Final Report to the Solomon Islands on the Pricing of the Coral Sea Cable (CS2)
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About the Author:

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Acronyms and Abbreviations

Bandwidth	Capacity measured in Mbps or Gbps
CAWG	Cable Adoption Working Group for the Solomon Islands
CIR	Committed Information Rate; the guaranteed speed
CS2	Coral Sea Cable lining Honiara to Sydney
EVC	Ethernet Virtual Circuit
DFAT	Department of Foreign Affairs and Trade, Australia
FTTN	Fibre to the node network (local broadband access network)
FTTP	Fibre to the premise
G	Gigabits per second, Gbps
GB	Gigabytes = 1,000 MB
HFC	Hybrid Fibre Coaxial cable (used for local broadband access)
IPT	Internet Protocol Transit (delivery to the global internet)
ISP	Internet Service Provider (aka Retail Service Provider)
IX	Internet Exchange Point or IXP
M	Megabits per second

Note on conversion of G to GB
In this paper it is assumed that average utilisation of bandwidth is 70% and that the ratio of download to uploads is 100:25. Both assumptions can be revised with real data (which may vary for each ISP).

MB	Megabytes
NBN	Australian National Broadband Network
NICTA	PNG's telecoms regulator
One Desk	Resale by large ISP or RSP to smaller operators
PIR	Permitted Information Rate; up to which bursts of traffic above the CIR are allowed after which they are dropped
PNG	Papua New Guinea
RSP	Retail Service Provider (also called an ISP)
SISCC	Solomon Islands Submarine Cable Company
SIDN	the Solomon Islands Domestic Network
SIG	Solomon Islands Government
T	Terabits per second = 1,000G
TCSI	Telecommunications Commission of the Solomon Islands
Traffic	content delivered through the cable measured in bytes

USD US dollars
All $ in the report are USD unless stated otherwise

1 Summary

The Solomon Islands Government (SIG) sought advice on submarine cable pricing (structure, level and competitiveness with satellite), impact on the retail market (particularly in provincial locations), future demand (including adoption and price elasticity of demand), the impact of SISCC products on the market (including IP Transit, neutral IXP peering and content caching) and the viability of the SISCC business (including economic aspects of policy and governance).

Key observations and recommendations are shown in bold.

1.1 Pricing

A new era of broadband internet has dawned in the Solomon Islands with the opening of its first international (CS2) and domestic (SIDN) fibre submarine cables.

- International connectivity was a major bottleneck with around 2G (Gigabits/second) of satellite capacity. 20,000G (2T) is available over CS2 with 200G lit now (half of which is for protection[1]).
- Domestic connectivity between the main islands of the Solomons has relied on wireless and satellite links. The new Solomon Islands Domestic Network (SIDN) links Honiara, Auki, Taro and Noro with fibre.

The pricing structure should reflect the new era of abundance if the potential of the new submarine cables to transform the economy and society is to be fully realised.

Normally capacity is priced on bandwidth purchased. Wholesale customers buy only what they expect to need - leading to some oversupply much of the time and not infrequent undersupply. It is recommended that SISCC adopt traffic pricing so that customers not only pay only for what they use but also have abundant capacity available whenever needed. **SISCC will not sell port capacity.**

The level of CS2 bandwidth pricing was chosen to be competitive with current satellite pricing. Traffic pricing has been calibrated the bandwidth pricing determined by SISCC.

The **proposed traffic prices for CS2** are:
Basic = $25,000 pm + 18cents/GB
Entry level price = 45 cents/GB

The **proposed traffic prices for the SIDN** are:
Basic = $6,000 pm + 1.5 cent/GB
Entry level price = 5 cents/GB

[1] It is not the fibre that is protected – if one pair breaks so does the other. But the Alcatel Optical Line Terminal (OLT) has two modules; one for each fibre pair. It is the software on one module that may fail.

Note that **both sets of prices have a self-selecting entry level price**: above 86,000GB pm (equivalent to 300Mbps) on CS2 and over 144,000GB pm (about 500Mbps) on the SIDN, the wholesale customer will opt into paying the basic price.

Competitiveness with satellites is discussed in Section 3.3

Details of the 7 main differences between the two approaches to pricing are discussed in Chapter 3 below.

1.2 Retail market

The submarine cable investments by the Solomon Islands and Australian governments have been completed for reasons of economic and social development. In particular, governments have made a loss-making investment in the SIDN to help promote investment in the provinces.

The retail communications market is dominated by mobile (particularly prepaid) phones. In the provinces most phones are not suitable for making use of the broadband services that are available on more modern phones. And, many voice-only mobile users in the provinces will need to recognise the benefits before they choose to migrate to 4G.

On the supply-side, while the SIDN connects some major provinces to each other and Honiara, most of the population resides in small villages which are difficult to reach and where power supply may be unreliable or non-existent.

In more densely populated areas, there is more potential to release considerable pent-up demand with the advent of the submarine cable and the migration to 4G phones.

Analysis of the retail broadband market shows that the implicit retail price of prepaid mobile data is $9/GB while the price of wholesale international connectivity will be well under 50cents/GB. There is a duopoly in the retail mobile market. Even without reductions in wholesale costs, there should be scope for falls in retail pricing. This could be aided by traffic pricing which encourages new entrants; as explained in Section 3.7 below.

1.3 Future demand

The level of demand is critical to the success of government objectives and the financial viability of SISCC. Removing barriers to continued growth makes social and economic sense.

A simple demand model is developed in Section 6.1 based on different scenarios on the growth in the number of active prepaid users, the migration to 4G and monthly data usage. After scaling-up, the mass market capacity demand in 2024 ranges from 8.5G to 28.4G (before considering price elasticity).

A number of sanity checks based on international comparisons are applied in Section 6.2.

In considering price elasticity (Section 6.3), it is assumed that initial wholesale prices are 40% below previous levels and that international connectivity represents about 25% of a retail operator's costs. That means retail prices should fall at least 10%.

Further reductions in retail prices depend upon further reductions in the cost of international connectivity and, more importantly, on increased competition in the retail market. Traffic pricing should encourage new entrants to challenge the existing mobile duopoly.

If retail prices fall 10% pa, capacity demand in 2024 ranges from 11.4G to 38G.

There are both threats and opportunities to the growth in demand for international capacity (Section 6.4)

1.4 SISCC products

Apart from providing access to capacity on CS2 and the SIDN, SISCC has some other services which generally are good for the Solomon Islands.

The only reservation is the pricing of IP Transit (Section 5.3). When the Solomon Islands relied on international satellite connectivity, global internet IP transit (a connection to anywhere on the globe) was part of the service. SISCC has made IP Transit part of its initial product offering. But it has been persuaded not offer it for free. That is, it can be offered as an optional add on to the capacity purchased at a price.

It is likely that one or more of the retail operators might develop their own IP Transit arrangements in Sydney which they could then offer in competition with SISCC. **The TCSI needs to set a minimum price for SISCC's IP Transit product to give the opportunity for competition to develop**. SISCC has also indicated that it will exit this market within 5 years.

To its credit, SISCC will host a local IXP and the consequent local content caching even though it will reduce the level of demand for CS2 (Section 6.4). This is appropriate for SISCC to do as an instrument of government policy (Section 7.3).

1.5 SISCC viability

An economist's approach to identifying the costs of the CS2 has been used (Section 7.1). The initial value of assets drives the main costs that need to be recovered: deprecation and the return to capital. The value of assets is equal to the SIG equity in CS2 **of $19.6m assuming that DFAT would pay 2/3 for any replacement of CS2 in 25 years**[2].

The forecast of required wholesale revenues depends upon the return on investment (at least 15%; see Appendix 2), new investments and OPEX for CS2 (both from SISCC plan). This forecast does not depend upon demand.

[2] If the SIG and PNG have to bear the cost of a replacement cable, the initial asset value would be $65.6m

The cost per Mbps clearly does depend upon the level of demand. Our **low and high-end mass market scenarios see deficits in the first 4 and 2 years** respectively.

The cost model suggests that the price of CS2 in 2020 would have to be at least $300/Mbps (declining over time). The costs of CS2 for PNG must be very similar. Yet, the regulator has set an initial price for CS2 of $54/Mbps (See Section 7.2); which must be inadvisable as it is hard to see what level of demand could justify that.

Note that while demand on the new submarine cables is an issue for the commerciality of SISCC, the Solomon Islands still benefits. A good analogy is a new highroad linking two towns. It had to be done but traffic is not as high as expected because new refrigerated and other warehouses reduce the need to truck supplies. The submarine highways built by the Solomon Islands with the generous support of the Australian Government are not too big. **Modern submarine capacity comes only in one size: VERY BIG.**

Maui Sanford says that "*Most Pacific Islands submarine cables in service since 2008 are used only up to 1% of design capacity*"[3]. That is not a big deal. The design capacity of CS2 is 20,000G so 1% is only 200G which is above our 2024 forecasts for the Solomon Islands[4].

The fact that submarine cables are not filled is not relevant. They were needed and they enable the local hosting of content even though this subtracts from the demand for the international cable. Without the cable there would be no local hosting of content and all the benefits that flow from that.

The SI National Provident Fund (SINPF) may not be happy with low returns – although it will have mixed feelings since low prices are good for its 97.32% stake in the incumbent retail operator, Solomon Telekom. **It is conflicted.**

The SIG is entitled to take a broader view of benefits than can be found in SISCC annual reports (Section7.3). Among the SIG's objectives "*To make information and communications technologies available, affordable and accessible to all in Solomon Islands"*[5].

A significant non-commercial investment done to pursue regional development objectives is the SIDN. While SISCC operates the SIDN, it should need to recover only the operating costs. **The asset value for the SIDN should be taken off its books.** This implies that any replacement of the SIDN will be funded by the SIG.

[3] MS Consulting, Status of International Connectivity in the Pacific Islands Region and Perspectives, October 2019

[4] Even on major international routes, lit capacity is less than 30% of potential capacity https://blog.telegeography.com/three-things-investors-should-know-about-the-sub-cable-market

[5] National ICT Policy, 2015

2 The two approaches to wholesale pricing

Until now, there has been only one approach: bandwidth pricing. But in the context of abundant capacity, a new approach is desirable: traffic pricing.

2.1 Bandwidth pricing of CS2

Transmission capacity is normally sold on the basis of throughput, which is now measured in G (Gigabits/per second)[6].

The bandwidth multiple (BWM) is often used to look at the how the cost of bandwidth changes. Buying 10 times more capacity does not cost 10 times more. If the BMW is, say, 3 then that means buying 10 times more potential capacity costs only 3 times more.

SISCC International Pricing 2020			
Mbps from - To		Ethernet	BWM
100	499	99	
500	999	99	
1000	1999	99	10.0
2000	2999	77	
3000	3999	64	
4000	4999	57	
5000	6999	50	5.1
7000	9999	40	
10000	19999	30	3.0

The pricing of SISCC bandwidth is based on an ISP's aggregate bandwidth on CS2[7]. ISPs may require several EVCs to connect users to their chosen IXPs and caches in Sydney – or may buy optional IP Transport from SISCC over the top of the EVC.

2.2 Bandwidth pricing of SIDN

The minimum purchase requirement on the SIDN is 1G (to each of Auki, Noro and Taro) versus 100Mbps for CS2. SISCC justifies this on bundling SIDN and CS2 capacity:

"Bundling to 1GB has two objectives, the first being to allow the operators to make the use of it to grow regional services at zero incremental cost, meeting the government objective of spreading benefits to the regions and away from Honiara. The second is to minimise the provisioning effort in regional centres to keep costs lower"[8].

The first argument is based on the first 1G on the SIDN being free. It is not if CS2 capacity is not purchased. Discussions in the CAWG mean purchases of SIDN capacity

[6] Years ago, the standard measure was the STM1 which had a throughput of 155Mbps (155M)

[7] "*For avoidance of doubt the total volume of bandwidth of all products will be used in determining the monthly recurring costs. For example, an operator requiring 2.5Gbps of IP transit and 500 Mbps Ethernet will be charged at the 3Gbps rate and not at 2Gbps rate and < 2Gbps rate*" Pricing V2.2 Final December 2019

[8] Email 10th January 2020

can be made without purchases on CS2. Asking a customer to buy 1G on the SIDN when it does not want CS2 capacity (with 100Mbps minimum commitment) is unreasonable.

The second argument is that by provisioning 1G rather than, say, 100Mbps increments saves on provisioning costs. True. And traffic pricing does the same with over-provisioning (including for CS2 – see Section 2.3).

Partially offsetting the 1G steps in purchasing, SISCC has much lower pricing on the SIDN: $10 to $13 per Mbps at 1G versus $99/Mbps on CS2. But it still makes the minimum cost on the SIDN (if it not taken with CS2 capacity) $10,000 pm; which is a significant entry barrier.

SISCC Domestic Pricing on SIDN 2020				
Capacity Mbit /sec	**Monthly Charge USD**		**$/Mbps**	
	1 Year	3 Year	1 Year	3 Year
1000	12,500	INCLUDED WITH INTERNATIONAL	13.00	10.00
2000	16,250	13,000	8.13	6.50
3000	20,000	16,000	6.67	5.33
4000	22,500	18,000	5.63	4.50
5000	25,000	20,000	5.00	4.00
6000	26,250	21,000	4.38	3.50
7000	27,500	22,000	3.93	3.14
8000	28,750	23,000	3.59	2.88
9000	30,000	24,000	3.33	2.67
10000	31,250	25,000	3.13	2.50

It is government policy to have minimal barriers to entry[9]. **While there is bandwidth pricing of the SIDN, the rate card should start at 100Mbps with increments of no more than 100Mbps**.

2.3 Traffic pricing of CS2

Bandwidth pricing divides up the fixed bandwidth of an international pipe into fractions that are sold. Each buyer is guaranteed a throughput speed and can use as much or as little of the purchased potential capacity as they choose. But any capacity not used is typically not available for sale to others.

Traffic pricing charges for what is sent though the pipe - like charging for water by litres. Here it is Gigabytes of data. When the international link is has abundant capacity, all but the very largest users will get faster speeds than they would purchase in the bandwidth model. **Faster speeds stimulate more traffic**.

The (NCS5000) switch at SICC divides the 100G available capacity (another 100G is for protection) into various ports. SISCC argues that the minimum port size of 100Mbps is needed because this is "*the minimum effective bandwidth of a port on the International*

[9] Para 16 of National ICT Policy (2015) and the Telecommunications Act 2009. See Appendix 1.

network" (p5). Minimum purchase requirements pose significant barriers to entry. Palau's submarine cable rate card starts at 50Mbps.

With traffic pricing, SISCC does not sell ports. It sells GB of traffic with no restrictions. It will separate its wholesale customers traffic (e.g. to measure GB pm) by using different ports for each customer. SISCC would put each customer's traffic through ports with more capacity than they need because they are charged for GB not G**. SISCC should start by giving each wholesale customer 10G ports**. It costs the SISCC no more to provision 10G than, say, 2G for a customer. This allows much higher (uncontended) speeds and generates more traffic.

Bandwidth pricing reflects scarcity[10] and customers must acquire more speed than they need to meet peak demands. Traffic pricing is tuned to the abundance of capacity with the traffic pricing model reflecting the value delivered. Traffic pricing is very simple: just a fixed price per month plus x cents per GB.

We can calibrate **initial** traffic pricing with bandwidth pricing using two explicit assumptions:

- ❖ First, bandwidth priced capacity will not always be full. The following two charts for CS2 and SIDN assume average utilisation of 70% of purchased bandwidth. Note that this has nothing to do with burst traffic (CIR, PIR etc). With traffic pricing, bursting is encouraged. No traffic is dropped and services that might otherwise be throttled by the ISP or the end provider will run unthrottled potentially leading to revenue growth.

- ❖ Second, traffic can be counted both ways. The charts assume that for every 100GB down there is another 25GB uploaded.

  ISPs do not count both-way traffic yet because almost all pre-paid traffic is probably download[11]. Historically, consumer internet has been largely one-way; usually downloads of US based content. But that is changing with uploads of video clips and other content likely to become dominant. If retail operators are not charging both ways now, they should think about it. Of course, the unit price of data will be lower when charging both ways.

With traffic pricing, **SISCC can over-provision the bandwidth to IX Australia.** It costs no more to have 100G than 40G[12]:

[10] In the Australian NBN, bandwidth-like pricing (the CVC) imposes artificial capacity constraints where none exist. See https://deridder.com.au/wp-content/uploads/2017/08/Economuse-2017-8-10.pdf

[11] In Australia, Telstra has been counting retail traffic both ways for years.

[12] Table from https://www.ix.asn.au/peering-pricing/

PEERING PRICING

As all peers must be a member of the Internet Association of Australia Inc, when selecting a plan you will be directed to the IAA signup page.

Want to start a free trial on one of our peering points? Please contact us to arrange a trial today.

10GigE Plan	40GigE Plan	100GigE Plan
$350 / month *	$1250 / month *	$1250 / month *
10 GigE	40 GigE	100 GigE (available in select locations**)
Fibre	Fibre	Fibre
Sign Up	Sign Up	Sign Up

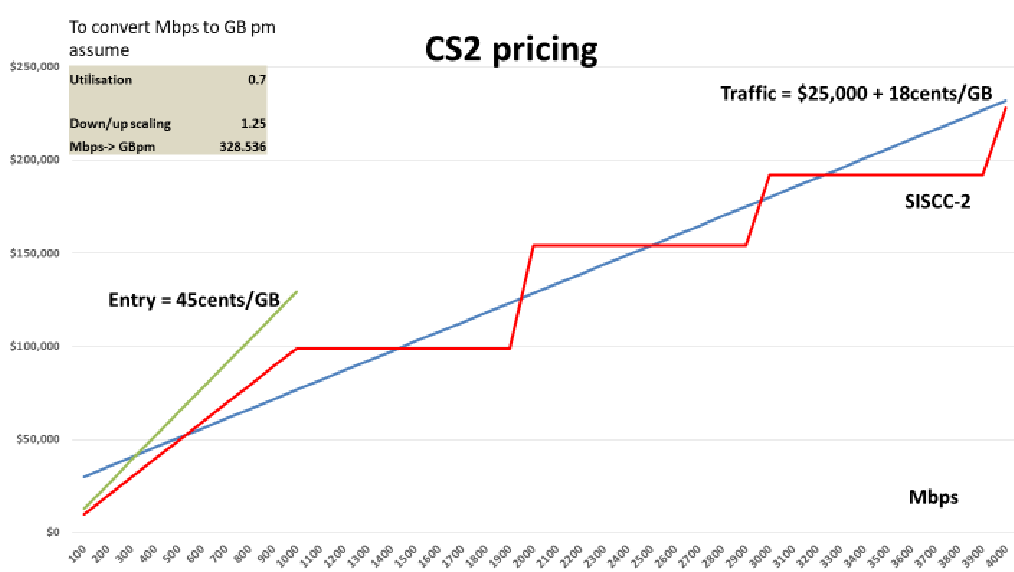
* All prices are in Australian Dollars and exclude GST

** 40G/100G only available in some locations. Set up fees may apply.

CS2 has an end point at Telstra's Paddington exchange (363 Oxford Street) but the **network boundary should be at the nearest IX Australia "meet me" place hosted by Equinix** which is 6km away (SY 3 at 47 Bourke Street) or at another suitable nearby Equinix facility.

The prices for CS2 wholesale sale prices are:

Basic = **$25,000 pm + 18cents/GB** (the red line is the SISCC bandwidth price)
Entry level price = **45 cents/GB** (green line)



(Source: Cell I59, Offers/Pricing workbook)

Note **the entry level price is designed to be a self-selecting entry-level price.** When the new entrant has more than about 86,000GB pm, it becomes cheaper for it to migrate to the Basic CS2 wholesale pricing.

The traffic price per GB should be zero between midnight and 6am. With bandwidth pricing, capacity is empty in these hours and so the marginal cost is zero. Traffic pricing needs to mirror this.

ISPs may provide corporate/embassy leased lines to Sydney. Traffic pricing at the wholesale level is compatible with ISPs selling international private leased lines (IPLs) over ethernet virtual circuits (EVCs).

Under the traffic pricing, there is some initial uncertainty in the revenues that SISCC can expect. **If bandwidth pricing is to be used in the first year, it will be possible to track what revenues would have been generated using traffic pricing if the volume of GB (not G) is monitored.** These volumes will not reflect the higher volumes that will come with traffic pricing.

Uncertainty for SISCC's wholesale customers would be reduced with traffic pricing. With bandwidth pricing, its customers have to forecast the number of customers, the mix of promised speeds and set contention ratios to throttle demand. With traffic pricing, they have every incentive to increase demand (**every byte is profitable**). There is no cost uncertainty. They do not have to target fill ratios for purchased bandwidth.

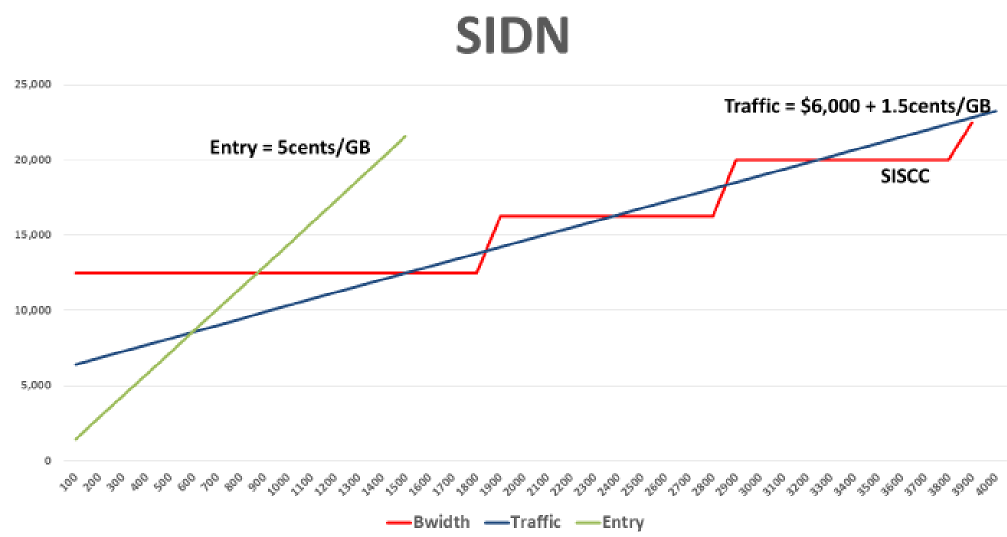
All the prices need to be revisited as traffic volumes rise and as competitive wholesale alternatives become available.

2.4 Traffic pricing of SIDN

Traffic pricing can also be applied to the SIDN. Following the same approach as for international where we target SISCC's pricing.

The formula for the SIDN is:

Basic = **$6,000 pm + 1.5 cent/GB** (the red line is SISCC pricing with a minimum 1G)
Entry level price = **5 cents/GB** (green line)



(Source: Cell D62, Offers/Pricing workbook)

With traffic pricing, port capacity is not sold. The 1G steps become a non-issue. There are no steps with volume charging.

3 Comparisons

The table and detailed explanations that follow discuss how the two pricing paradigms differ and the consequences.

Item		Bandwidth	Traffic
3.1	Value for money	Buy large lumps	Pay only for what you use
3.2	W'sale customer profit	Squeeze each lump	Every byte is profitable
3.3	Satellite competition	Quality and price	Harder to compare prices
3.4	A paradigm shift	Tradition (scarcity)	Fibre (abundance)
3.5	Speed	PIR constrained	No constraint in fibre
3.6	Retail pricing	Unlimited retail data	Unlimited retail speed
3.7	Competition	Favours large operators	Lowers barriers to entry

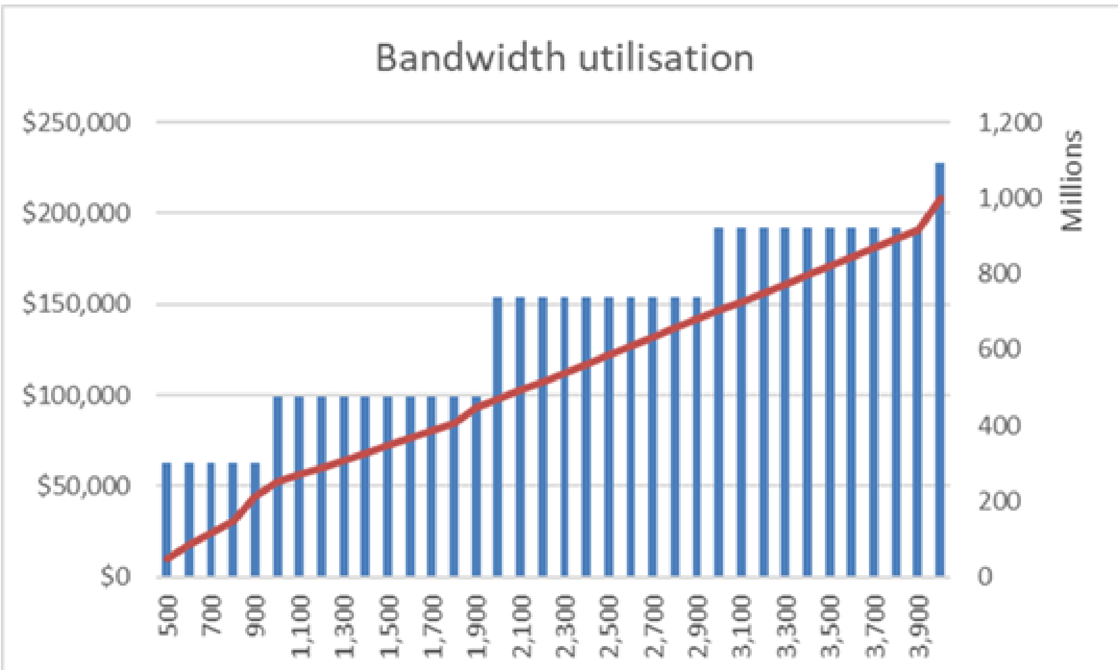
3.1 Value for money

The minimum purchase on CS2 with SISCC bandwidth pricing is 100M (1G on the SIDN) with step changes of 1G after that on both CS2 and the SIDN. **The unit price of used capacity therefore depends upon utilization.** And, the step changes in purchase requirements **discourage smaller operators** and cause all operators to use contention to get more out of limited capacity. They buy only what they think they can use.

In Australia in 2017, most ISPs were using provisioning less than 1Mbps per user while an ISP in Tasmania claimed to provision 3Mbps and 20Mbps per user over FTTN and

FTTP respectively[13]. ISPs have been complaining about the NBN's (CVC) charging of this provisioning as they need more and more for video streaming.

High prices for bandwidth "*put pressure on Telcos/ISP to purchase less capacity than demand"*[14]. The ICT consultant, Matthew Mann, has observed that for ISPs in other markets "*Their capacity management is very challenging, as they need to provision 80% of their traffic, and then when they have a growth spike they need to scramble to ensure they don't start dropping traffic due to exceeding the 95% percentile conditions on their commitment. Troublesome, but the industry is 'used to it'* ".



(Source: Pricing-1. The red line is the maximum download GB millions)

With traffic pricing, bursting is encouraged. No traffic is dropped. No ISP needs to contract for a specified capacity. ISPs are charged only for the traffic they actually sell. More speed means more traffic; as the evolution of mobile technology shows us.

3.2 Industry profitability

If only 30% of purchased bandwidth capacity is used, then the unit cost is three times more than if 90% is used. **This favours larger operators over smaller operators**. Given the need to buy large lumps of capacity, this tends to lead to using contention to get more out of purchased capacity; which **degrades retail customer experience**.

[13] https://deridder.com.au/wp-content/uploads/2017/07/Economuse-2017-7-31.pdf

[14] MS Consulting October 2019 quoted in slide 12 presented to CAWG-2

With traffic pricing, every GB is profitable because it is caused by and charged to a retail customer. And, there is no step change in required purchase capacity so that there is a strong incentive to increase demand without degrading the user experience.

3.3 Competitiveness with satellite

Information on current satellite pricing received this month (January) from Maui Sanford is that the "*current trend is 100 US$ a Mbps simplex per month or* ***200US$ / Mbps duplex if you want to compare apple to Apple***". An ethernet connection over fibre is a duplex (both-way) connection – that is the apple.

Fibre should be priced at a premium to satellite because of its superior capacity and quality (e.g. fibre is not subject to rain fade). Also, if there a drop-out on satellite the operator may disappear from the routing table (local operator).

There's simply no viable alternative to the world's critical submarine cable infrastructure. Satellites need not apply because they cannot compete with the required capacity, performance, availability, security, or cost points of existing high-speed optical networks, overland or undersea.

OneWeb is due to come into service over the Solomon Islands in mid-2021. An MIT report comparing OneWeb, SpaceX and Telesat's new satellite services[15] estimated OneWeb's data rate to be under 10G versus 100G now on CS2.

The PNG regulator, NICTA, has determined that satellites do not constrain submarine cable pricing: "*the next best alternative for submarine transmission is clearly not to provide satellite or radio link services. Rather, if these services were generally available alternatives to submarine cable services (which they are not) their pricing might constrain submarine cable prices.*" (p9 response to submissions, December 2019)

Satellite will remain indispensable for access into and out of remote and inaccessible areas. Also, with back-up: the capacity is purchased so it will be used.

It is also important to note that while end-users (e.g embassies) have to deal with one of the three licensed retail operators to access submarine cables, **they can and do have direct relationships with satellite operators that by-pass local retail operators**.

Traffic pricing makes it harder for satellite operators to compare pricing. They can, of course, make the same translation that SISCC will use to set initial traffic prices comparable to its bandwidth prices. But this will not be as easy as the current head to head comparison of price per Mbps as it requires making assumptions that will vary by operator and over time.

[15] MIT October 2018 report http://www.mit.edu/~portillo/files/Comparison-LEO-IAC-2018-slides.pdf

Once it starts using traffic pricing, **SISCC should avoid comparing prices on a per Mbps basis and should focus on the other strengths of fibre and traffic pricing:**

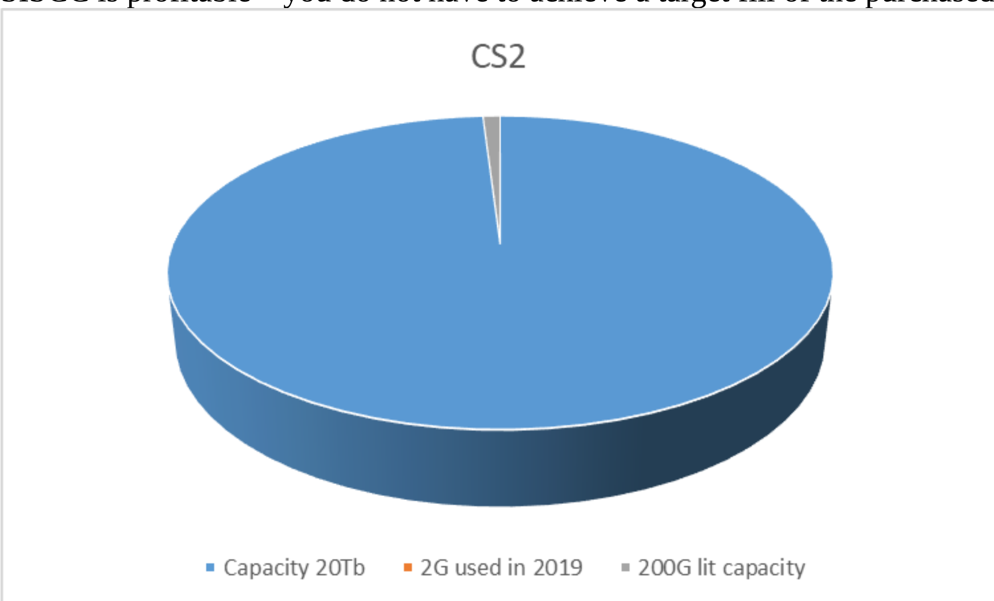
- Speeds are higher
- You only pay for what you use
- Every byte of traffic is profitable
- It is all delivered reliably (subject to infrequent outages)

It is expected that satellite pricing could come down quickly. SISCC's revenues based on traffic pricing are hitched to the growth in traffic. Even without satellite competition, the price per GB will need to fall so that revenues (once costs are covered) do not grow as fast as traffic – otherwise it would show monopolistic behavior.

3.4 A paradigm shift

Bandwidth pricing has been the norm. But it reflects scarcity. It is not aligned with much retail pricing where monthly data caps are the norm – you pay more for a larger monthly data allowance.

Traffic pricing reflects abundance. There is no need to make RSPs manage international bandwidth – there is a lot of it. Nobody bears a risk here. All traffic passed through SISCC is profitable – you do not have to achieve a target fill of the purchased bandwidth.



(Source: Cell AT33, TCSI/BBM workbook)

Bandwidth pricing is the norm only because of tradition. The first submarine communications cables such as the first transatlantic cable in 1858 carried telegraphy. Subsequent generations of cables carried telephony. Now modern cables use optical fibre to carry digital data, which includes telephony, internet and private data traffic. Mobile data overtook voice traffic in 2009[16].

[16] https://www.theinquirer.net/inquirer/news/1598177/mobile-overtakes-voice-traffic

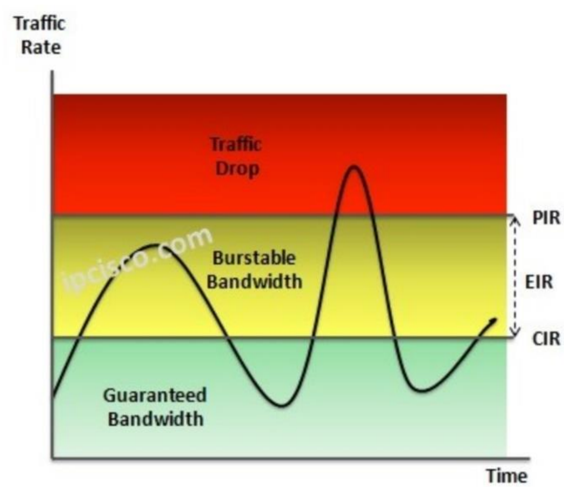
Wholesale pricing from the era of circuit switched traffic need not apply to the current era where everything is carried as digital data.

A software upgrade to the SISCC switch is all that is required - it is not a big investment. Counting bytes probably takes less effort than tracking the 95th percentile and may be fairer": *"Critics of the 95th percentile billing method usually advocate the use of a flat rate system or using the average throughput rather than the 95th percentile. Both those methods favour heavy users (who have interest in advocating for changes to billing method).* ***Other critics call for billing per byte of data transferred, which is considered most accurate and fair****"*[17].

Purchasing bandwidth is not easy – you have to make assumptions about the interaction of speeds, number of customers, contention ratios and then round-up purchased capacity to what is required on the rate card for the steps in capacity orders.

Traffic pricing is easy (ask Microsoft Azure cloud services). RSPs only pay for what they use – just like any utility.

3.5 Speed constraints



SISCC bandwidth pricing requires the wholesale customer to choose the guaranteed throughput (the CIR, committed information rate) and the maximum throughput (the PIR or permitted information rate): "*SISCC will allow bursting of traffic above the CIR* ***to the limit of the PIR*** *for up to 5% of time (measured by 1 minute traffic samples in SISCC systems throughout the month) every month without charge*"[18].

If the bursting occurs for more than 5% of the time, the entire overage is billed at some fee per Mbps. This overage fee may be the cost per Mbps of the CIR bandwidth purchased. The "*monthly recurring excess charge per Mbps*" is not known.

It is not clear what happens when bursts exceed "*the limit of the PIR*". The CISCO chart[19] suggests that data packets may simply be dropped.

With bandwidth pricing Solomon Telekom buys, say, 2G from SISCC. This speed is guaranteed. It is the committed information rate (CIR). But with fibre on CS2 and the SIDN throughput is virtually unlimited – capacity is abundant. Why ration it?

---

[17] https://en.wikipedia.org/wiki/Burstable_billing
[18] P6, SISCC Launch Pricing
[19] The illustration is from https://ipcisco.com/lesson/cir-and-pir/

With traffic pricing, there is no need to set CIR and PIR so there are no excess charges. Speed and burstiness do not need to be constrained.

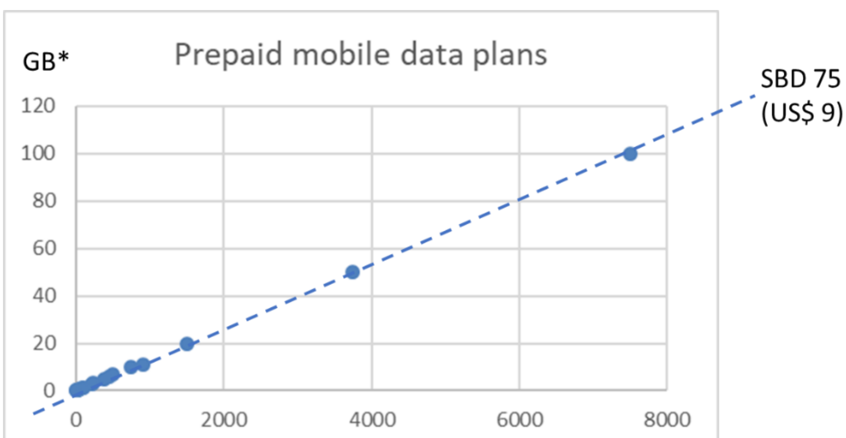
Usage based pricing with higher speeds inevitably leads to higher consumption. When clicking on something gets an instant result – you click more.

The speed bottleneck shifts to local access networks.

3.6 Retail pricing

With bandwidth pricing of submarine cables, nothing much will change. It is how satellite capacity is priced now. There will be a short-term boost from lower prices of international capacity over CS2 (followed by pressure from future satellite pricing) and the speeds should be higher (constrained only by local access networks). That's it.

Before we consider the impact of wholesale traffic pricing, consider current retail broadband pricing based on satellite connectivity. There is a simple method for looking at retail broadband pricing that I have been using to track the retail broadband market in Australia annually since 2008 (all reports on my site). Applying this to the Solomon Islands shows that **the implicit price of data in retail prepaid mobile plans is $9/GB (SBD 8.12= US$1) versus less than 50 cents per GB at the 1G level for CS2**[20].



(Source: Chart at G22 Retail/Pricing workbook)

Both Telekom and bemobile price prepaid mobile data not only on GB (as in the scatter chart above) but also on term (days of validity). The prices used in the scatter chart above are shown in the first part of the following[21]. The middle section shows the result of estimating the SBD cost of each plan against GB and days (second "X variable"). GB clearly drives the cost of the plans. You would expect to pay more for longer term but the Telekom coefficient of -2.4 says that you would pay less; which is probably not what it intended.

[20] The scatter includes Satsol top-up options. Without Satsol, the implicit cost (slope) is US$9.7/GB.

[21] There are a couple of minor changes to Telekom pricing since the analysis was done. No other changes.

You would not be able to see the difference between actual and predicted. So instead I have used the estimates to predict the cost of plans – the last section shows that Telekom's prepaid mobile plans are cheaper than for bemobile.

Pre-paid mobile plans in the Solomon Islands

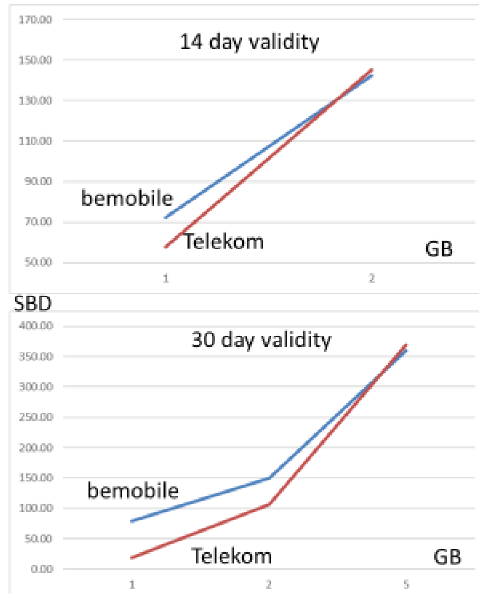
	SBD	GB	Days
Bemobile	6	0.09	1
	15	0.225	2
	20	0.4	3
	50	0.75	7
	90	1.25	14
	220	3	30
	500	7	30
Telekom	6	0.09	1
	15	0.21	7
	20	0.25	7
	20	0.4	4
	50	0.76	6
	100	1.5	14
	240	3.5	30
	450	6	30
	900	11	30
SatSol top-ups	375	5	
	750	10	
	1500	20	
	3750	50	
	7500	100	

bemobile

	Coefficients	andard Errc	t Stat
Intercept	-4.21405	1.925493	-2.18855
X Variable :	70.04434	1.157036	60.53775
X Variable :	0.458442	0.225835	2.029987
US$/GB	$8.63		

Telekom

	Coefficients	andard Errc	t Stat
Intercept	3.583309	4.741902	0.755669
X Variable :	87.67484	1.494636	58.65966
X Variable :	-2.40326	0.452674	-5.30903
US$/GB	$10.80		



Source: Retail/Pricing workbook)

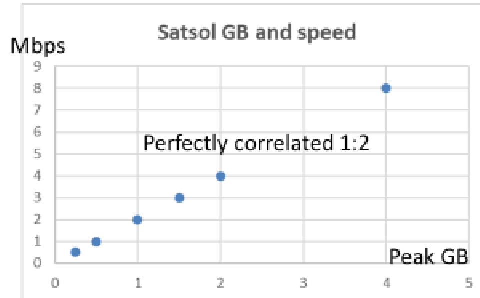
In the prepaid mobile plans:

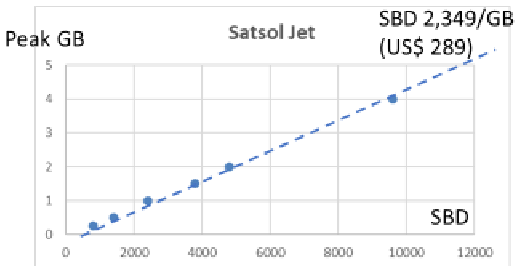
- There are no excess data charges. If the allowed GB is used up before expiry of the plan, the customer sends a text to his or her provider asking for another plan.
- There are no speed restrictions. You get what you can from 3G or 4G mobile.

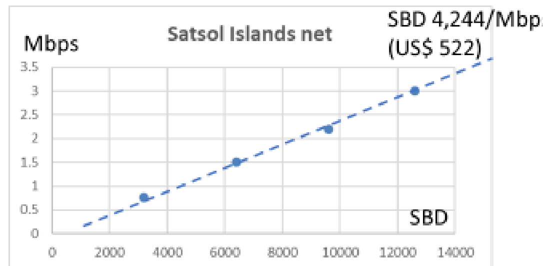
There is no reason for this form of pricing to change with traffic pricing. Prepaid users probably feel they have good control of their budgets with this regime. Telekom and bemobile can continue with this form or pricing whether wholesale is priced on bandwidth or traffic; passing on savings though reduced plan prices or including more data in each plan.

Satsol currently has also relied on satellite for international connectivity and will probably continue using satellite plus fixed wireless for local access. It has a different approach to retail pricing, as shown below.

	SBD pm	peak data	mbps
Satsol Jet	800	0.25	0.5
	1400	0.5	1
	2400	1	2
	3800	1.5	3
	4800	2	4
	9600	4	8
Satsol islands net	3200	unlimited	0.77
	6400	unlimited	1.5
	9600	unlimited	2.2
	12600	unlimited	3







Source: Retail/Pricing workbook

In the Satsol Jet plans, pricing is done on peak (GB) data (free between 11pm and 8am) and speed (reduced to as little as 250Kbps when the peak time allowance is exhausted).

Unfortunately, we cannot unpack the explanatory contributions of data and speed because they could be proxies for each other (top right chart): you can estimate the effect of one on price or the other but not both.

Based on data alone (bottom left hand chart), the implicit price of data is $289/GB. The implicit cost of Jetstream data packs (previous page) is just $9.2/GB (SBD 75/GB).

The Satsol Islands net plans charge only for speed. The estimated cost of speed is $522/Mbps (bottom right hand chart). Its "*full flexibility*" requires the customer to "*choose the contention ratio, bandwidth/speed, latency and the guaranteed service availability that you need*"[22].

Unlimited data plans are profitable but not a good idea:

- In Australia, retail plans were priced on monthly data caps. Now few are. "Unlimited" has become standard. ISPs can do this because they understand **consumers are prepared to pay for certainty**.

  In September 2015 Optus charged A$125pm for unlimited data over an NBN 100/40 line. I estimated[23] that the implicit cost of data was 45cents/GB for downloads of 100GB pm (and higher for lower volume). The best fit based on

[22] : https://satsol.net/jet-plans/)

[23] https://deridder.com.au/wp-content/uploads/2015/09/Economuse-2015-09-29.pdf

100/40 plans that had data caps was $80 + 5cents/GB so that 100G would cost just $85 versus the $125 charged by Optus.

Optus and others know that unlimited is attractive and will not put them out of business. They know that the (arithmetic) Mean usage that is usually reported is influenced by very heavy users – who can be made subject to "*fair use*" polices to constrain their usage. The Mode is the most frequently occurring usage and was just 1 GB or less on the NBN when I last looked (2016). The Median average is about half the Mean and has exactly the same number of users above and below this.

- It is not a good idea to have unlimited data because **charging for data is the only way not to be relegated to a "*dumb pipe service*"**.

  Netflix, Skype or other over-the-top (OTT) operators have direct relationships with end customers over the heads of retail providers; who are increasingly complaining of the 'free ride' they have to give the OTT players. Hugh Bradlow, Telstra's CTO, once said "*the biggest challenge we have today as an industry is that the rise in data is not commensurate with the rise of revenues ... if that trend continues, we shall see a shortage of investment in infrastructure which makes it all possible*"[24]

  When WhatsApp announced in Barcelona in February 2014 that it would offer voice services as well as text, the different comments from two multi-national carriers on the expected impact is instructive:

  - The CEO of Millicom, which started in Sweden and operates mobile services under the Tigo brand in Africa and Latin America, begged WhatsApp to "*take it easy -70% of our revenues come from voice*".

  - But the CEO of Tele2, which also started in Sweden and operates mainly in Europe, said "*Customers get voice and SMS for free. Sorry Mr WhatsApp, but it's free in the Tele2 world*". Tele2 saw the future and started charging for data in order to hitch its revenues to the growth in data and insulate itself from revenue losses due to OTT services.

With only a few exceptions[25], the structure of wholesale pricing does not constrain the structure of retail pricing. The market left to its own devices will find opportunities in the move to traffic pricing.

[24] https://deridder.com.au/wp-content/uploads/2014/05/Economuse-2014-04-30.pdf

[25] One exception is unbundled bitstream (broadband) where Telecom New Zealand (TNZ) charged business customers more than residential customers. When the NZ Commerce Commission set a price for wholesale bitstream services supplied by TNZ, it ruled that there was no difference in cost between supplying a wholesale service intended for business versus residential users. Faced with a single wholesale rate, TNZ was the first to make its retail prices the same for business and residential users – before other operators poached its business customers.

3.7 Competition

Section 3.6 suggested that there is a lot of scope for retail prices to fall without any change to the cost of international connectivity. There is not likely to be any significant change in the intensity of competition under bandwidth pricing. But traffic pricing can change that by lowering entry barriers.

Bandwidth purchasing is a barrier. It is lumpy and discriminates against small operators (See Appendix 1). Smaller capacity increments under bandwidth pricing helps. But traffic pricing is even better and is designed to encourage entry.

SISCC is not vertically integrated into the retail market. That "*structural separation*" helps if there are no grey customers. The ICTSU, which provides the desk for ordering all SIG requirements for ICT services, is proscribed from purchasing directly from SISCC. But what about, say, a major bank?

Without being able to achieve the economies of scale that it would enjoy under bandwidth pricing, Telekom will be under pressure on a level (traffic pricing) playing field. As the "*dominant supplier*" (except in the mobile market), its actions are more constrained (e.g. in offering targeted customer discounts) and it has obligations to provide services in non-commercial areas. So **Telekom is vulnerable to the cherry-picking of its profitable urban services**. It will need policy support.

4 Precedents

The next question after "Why should we move from traditional bandwidth to traffic pricing?" is inevitably "Where is wholesale traffic pricing done now?"

4.1 The Australian National Broadband Network (NBN)

The idea of wholesale traffic pricing of broadband capacity comes from work in 2008 advising TransACT on its bid to provide the FTTN (fibre to the node) access network in the Australian Capital Territory.

The view was taken that wholesale pricing should support retail broadband pricing; which at that time had monthly prices that rose with the size of the monthly data allowance. A best-fit regression through retail plans describes the retail broadband market[26]. A line parallel and below that sets the wholesale price as a fixed price plus a usage charge.

This was radical because until that time all wholesale access pricing was a flat charge per month. TransACT's bid was not accepted because it had two pre-conditions:

- "*one pillar - one provider*" so that there would be no sharing of pillars or cabinets. In fact, TransACT already had FTTN in place for over a decade which never

[26] Annual reports on retail broadband pricing following this method are on my site www.deridder.com.au

made a profit because Telstra refused to use it even though its quality was better than Telstra's[27].

- "*no going backwards*" so that the Telstra pillars TransACT did not need could not be used to overbuild another FTTN access network. But it would allow overbuilding with FTTP (fibre to the premise) as that would not be going backwards technologically.

In 2008 Australian policy makers and the regulator did not accept limits to competition. But when there was a shift from a value for money FTTN to an open-ended FTTP network built by a government start-up company, harsher competition restrictions were imposed to prop-up the economics of the NBN; e.g. requiring Telstra and Optus to close their HFC (coax cable) networks, migrate all their customers to the NBN and not promote their mobile networks as an alternative to the NBN.

The NBN saw from the TransACT bid that hitching revenues to traffic is smart. But the way this was done on the NBN was bad. It decided that *"CVCs can be used as proxies for usage charging"* [p103, NBN Corporate Plan, Dec 2010]. That was a mistake. CVCs impose artificial scarcity. RSPs have been buying only what bandwidth (CVC) they need and are complaining[28].

4.2 Electricity wholesale pricing

The electricity market consists of generators, transmission and retail. All use "traffic pricing" where the unit price is cents per Megawatt hour.

In the middle is the Australian Electricity Market Operator (AEMO) which interconnects the six eastern and southern states and territories and delivers around 80% of all electricity consumption in Australia[29].

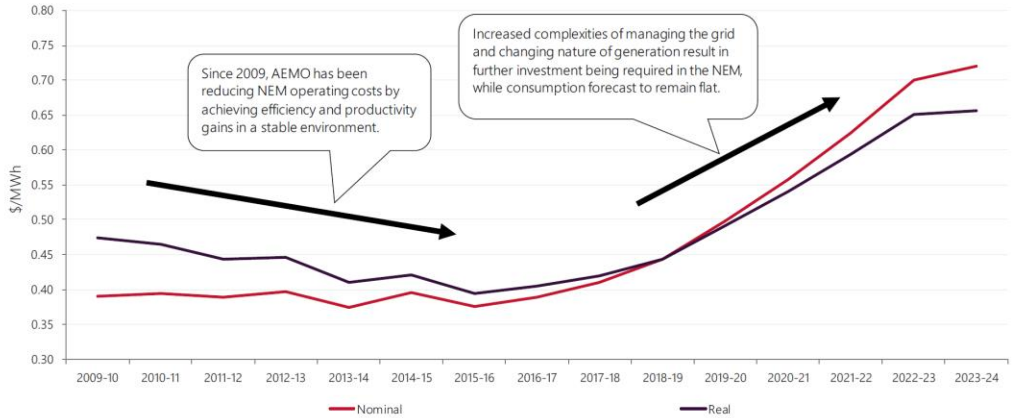
As transmission is a natural monopoly, prices are regulated[30]. The current regulated fee is 50 cents/MWh and is projected to increase to fund investments and also reflects stagnant demand (due to solar panels).

[27] It used Cat5 copper; not legacy copper on its FTTN.

[28] See https://deridder.com.au/wp-content/uploads/2017/08/Economuse-2017-8-10.pdf

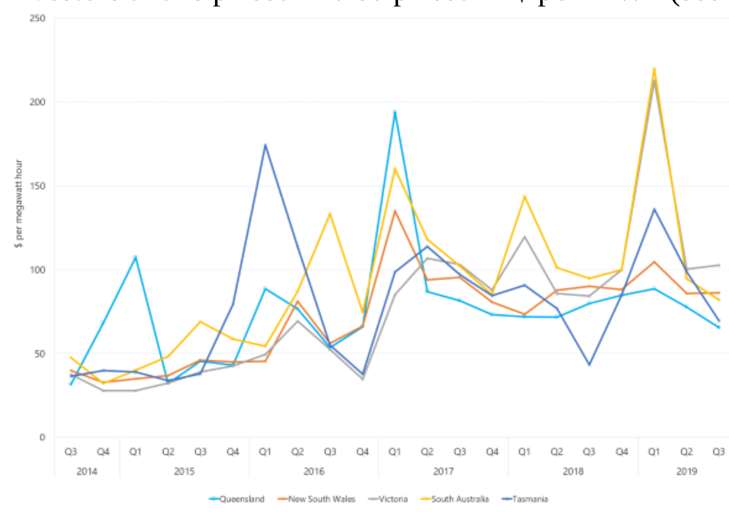
[29] Western Australia and the Northern Territory are too far away to be connected. They have their own electricity systems and separate regulatory arrangements

[30] https://www.aemc.gov.au/energy-system/electricity/network-regulation



Source: 2019-20 AEMO Final Budget and Fees, June 2019

The AEMO also coordinates the national energy market (NEM) which is a wholesale market where generators sell electricity and retailers buy it to on-sell. There are lots of generators and retailers participating, so it's highly competitive. The wholesale market operates around a common pool, or spot market, for wholesale trading in physical electricity. This process determines an electricity spot price which reflects physical supply and demand across the NEM. This spot price is an important price signal for investors and is priced in also priced in $ per MWh (see chart below).



Source: https://www.aer.gov.au/wholesale-markets/wholesale-statistics/quarterly-volume-weighted-average-spot-prices-regions

Financial markets sit alongside the wholesale market and involve retailers and generators entering into contracts to buy and sell electricity at an agreed price. The financial markets enable retailers to manage the risk of volatile wholesale prices for their customers.

Finally, the retail bill is expressed in terms of $/kWh with different rates for different times of day[31]. The retail market is contestable with the AEMO facilitating customers' desire to switch retail provider.

4.3 Canadian broadband access

Canada very nearly adopted "traffic pricing" for wholesale broadband access. In 2000 the cable companies were granted permission to charge wholesale per GB fees provided that they also charged their retail customers the same way.

Naturally, this appealed to the Bell Companies and they sought to apply aggregated volume pricing to their FFTN networks based on total traffic generated by an ISP's customers in a month. The cable companies supported a similar approach but the smaller operators represented by the Canadian Network Operators Consortium objected on the basis that peak network capacity drives network investment decisions whereas a volume based model would charge for both peak and off-peak traffic – note that **capacity constraints do not apply where there is abundant capacity**; as with CS2 and for which off-peak traffic would not be charged.

The Canadian regulator (CRTC) launched an inquiry[32] noting that all parties supported a two-part tariff. The issue was how usage should be charged: usage based versus capacity (bandwidth) based models.

The CRTC argued that usage-based billing was problematic because, even if volume is a proxy for traffic that drives additional network usage costs, the correlation between volume and peak traffic can change so that a total traffic algorithm might over or under-estimate costs. Again, **this is irrelevant in the context of CS2 with abundant capacity**.

The CRTC decided that there are two acceptable ways for large telephone and cable companies to charge independent service providers for the use of their networks: the flat-rate model, and the capacity-based model:

- Historically telephone and cable companies have used the flat-rate billing model. Under the flat-rate model, companies charge independent service providers a flat monthly fee per retail customer for access to the network. The independent service provider's retail customers may then make unlimited use of the network.

- Under the capacity-based model, independent service providers pre-purchase the amount of network capacity (bandwidth) that they expect to need to serve their retail customers. If demand exceeds the capacity an independent service provider has purchased, the provider must manage its network capacity until it can buy more. Independent service providers must also pay a monthly access fee for each of their retail customers.

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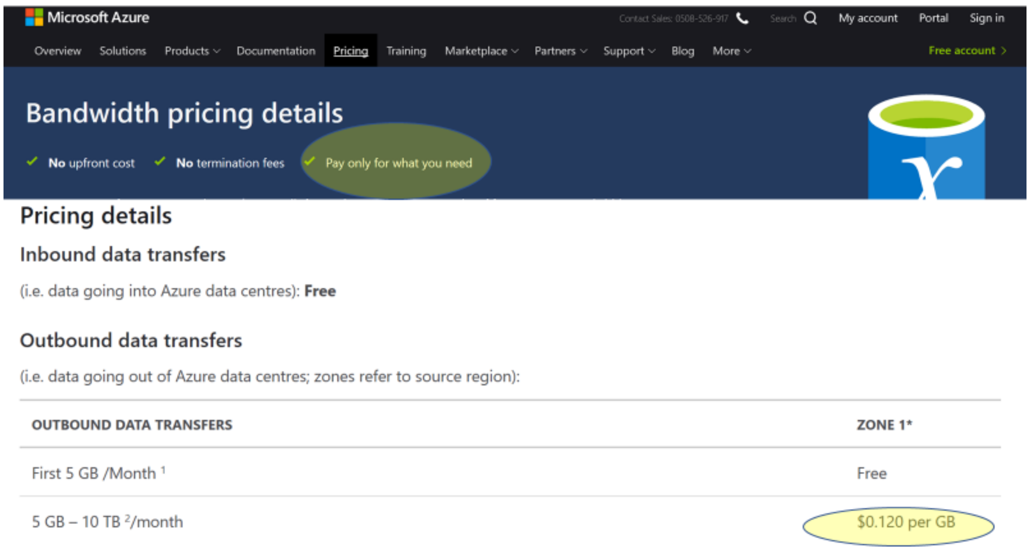
[31] See the following guide https://www.energymadeeasy.gov.au/help/electricity-bill
[32] http://www.crtc.gc.ca/eng/archive/2011/2011-703.htm

This approach is still being followed in Canada[33].

4.4 Cloud services

A current example of traffic pricing to scale is Microsoft's Auzure cloud service[34].



Amazon Web Service is charging for connected time. Neither charge for bandwidth.

5 Other pricing matters

The focus of the chapters above has been on bandwidth versus traffic pricing for the submarine cables. There are some related pricing matters which need to be discussed including other SISCC services like IP Transit.

5.1 Volume discounts

SISCC says that its pricing offer was premised on 3 customers and not on one customer on-selling capacity to others. Bandwidth pricing has inherent volume discounts. With a large player and two smaller players, "*one desk*" is inevitable with bandwidth pricing.

This is not the case with traffic pricing which gives the same wholesale price to everyone (leaving aside entry level pricing). But the CAWG would like to consider a volume discount to make the adoption of traffic pricing more palatable to Telekom.

One desk will still occur with modest volume discounts on traffic prices. Discounting could be done on either revenue or traffic. The orange line in the chart below is based on a discount of 5% over 0.5m GB pm and 10% for traffic over 1m GB pm.

[33] Current (2019) regulated pricing https://crtc.gc.ca/eng/archive/2019/2019-288.htm
[34] Amazon Web Service (AWS) cloud service is based on time.

(Source: Abundance.ppt)

The top half of the following table shows one-desk at work with SISCC bandwidth prices. The top right-hand number of $352,000 pm is what SISCC would get with 2 sales of 1G each and one at 2G. With one desk buying 4G, it loses $124,00pm.

The lower half of the table shows traffic pricing based on $25,000 pm + 18cents/GB and a discount to Telekom of 5% on its purchases. This is based on a traffic volume equivalent to 2.5G for Telekom. The other two ISPs have traffic equivalent to 1.5G priced with no discount. The SISCC revenue of $353,126 is almost the same as under bandwidth pricing in the top half of the table.

If Telekom buys on behalf of all three ISPs, it gets a discount of 10%. Even if it resells to the other two ISPs at the same price SISCC would charge them less 10%, its net cost falls from $147,893 to $93,925. SISCC's loss of revenue from one desk is smaller under traffic pricing than with bandwidth pricing.

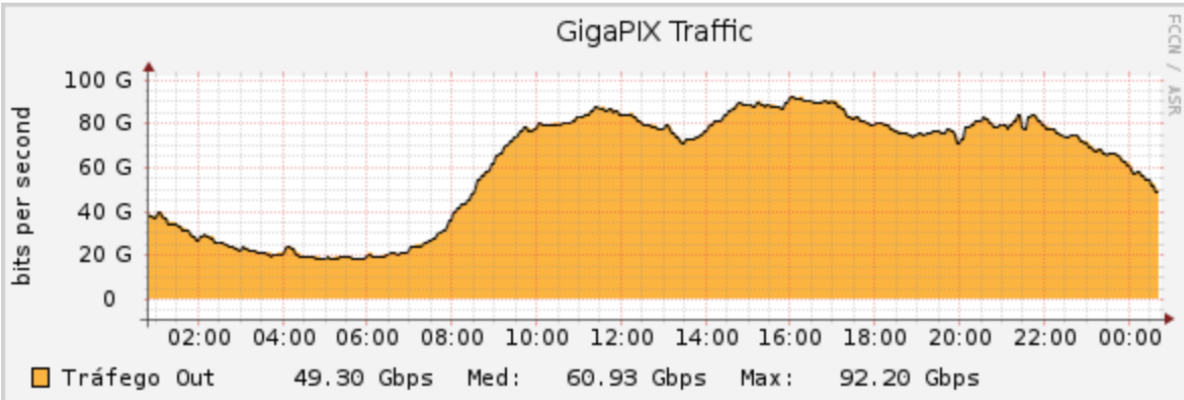
	Cost to T	Resell	T Revenue	SISCC	
2G	$154,000			$352,000	3 ISPs
4G	$228,000	2G @$70/Mbps	$140,000	$228,000	4G @ $57
Net cost	$74,000	plus resale rev =	$66,000	-$124,000	
Traffic with discounts					
0.7 TB	$147,893			$353,126	3 ISPs
1.6 TB	$278,635	2*0.4TB @90%	$184,710	$281,700	1.6TB
Net cost	$130,742	plus resale rev =	$53,968	-71,426	

Arbitrage is not anti-competitive[35].

5.2 Off-Peak Pricing

With bandwidth, the marginal cost for off-peak use is zero. This feature is used in Satsol's retail plans. To make traffic pricing more acceptable to Satsol, one option is to make traffic free off-peak. In my view, traffic pricing should be free of-peak both ways as the opportunities to displace traffic to the early hours are not large.

The chart shows a typical day at 5-minute intervals for the not-for-profit IX in Portugal[36].



5.3 IP Transit

SISCC developed an IP Transit (IPT) product because until now it has been bundled with satellite connectivity. But the major ISPs are perfectly capable of organising their own IP Transit on CS2. Any ISP that wants IP Transit could take IPT from SISCC - or from one of the three current ISPs[37].

Bundling in this context is forbidden[38]. IPT should not be provided for free as an optional overlay to an international circuit because it would distort the allocation of resources. With competition, the TCSI does not need to set a maximum price for SISCC's optional IPT. But **the TCSI should set a minimum price** so that SISCC does not forestall competition.

It is not appropriate to provide the detailed costs of SISCC's Sydney requirements to deliver IPT. Its IP Transit consists of Equinex Content access via the Superloop/MegaPort XC (at a fixed monthly fee) plus Optus or Telstra IP Transit (at

[35] See Appendix 1 on "One Desk"

[36] https://gigapix.pt/en/technical/traffic-stats/

[37] ICT consultant, Matthew Mann, says that the IPT product imposes unacceptable risks, reduces service provider autonomy, adds to SISCC costs, and implies a single failure domain across multiple future submarine cables. The SISCC should be able to sell its equipment and transit agreements in Sydney that it will no longer need.

[38] See Appendix 1

commercial-in-confidence rates) plus its own costs. The average cost depends upon on a lot of factors.

SISCC also has to recover the cost of its $0.5m CAPEX. Over 5 years and 1G of IPT capacity, it would need an extra $8.33/Mbps/pm for 5 years to recover CAPEX:

Mly IPT cost			Per Mbps pm	Per GB pm
	at 1G =	$6,000	$6.00	$0.0209

CAPEX		5 yr life	Per GB pm
	$500,000	Per Mbps pm	
	at 1G =	$8.33	$0.0290
Total		$14.33	$0.0499

(Source: cell N14 in Offers/pricing workbook)

If SISCC does not provide IPT, it will incur fewer costs in Sydney and could probably sell its local equipment that cost $0.5m.

On these figures, **IPT must be charged at least $6 per Mbps pm**.

With traffic pricing, SISCC charges cents/GB for IPT but pays $/Mbps (bandwidth) in Sydney. This means that when SISCC (or any ISP in the Solomons) pays, say, Telstra it has to take a view on how much bandwidth it needs to support expected traffic – just as ISPs do now for satellite capacity or to support retail plans that charge for data.

5.4 Non-recurring fees

SISCC's set-up charge for each of CS2 Ethernet, IP Transit is $5,000 and for three SIDN links together it is $10,000 (or $5,000 per link). While one-time set-up or installation cost are reasonable, the **charges seem high** and will raise entry barriers for new ISPs.

6 Forecasting Demand

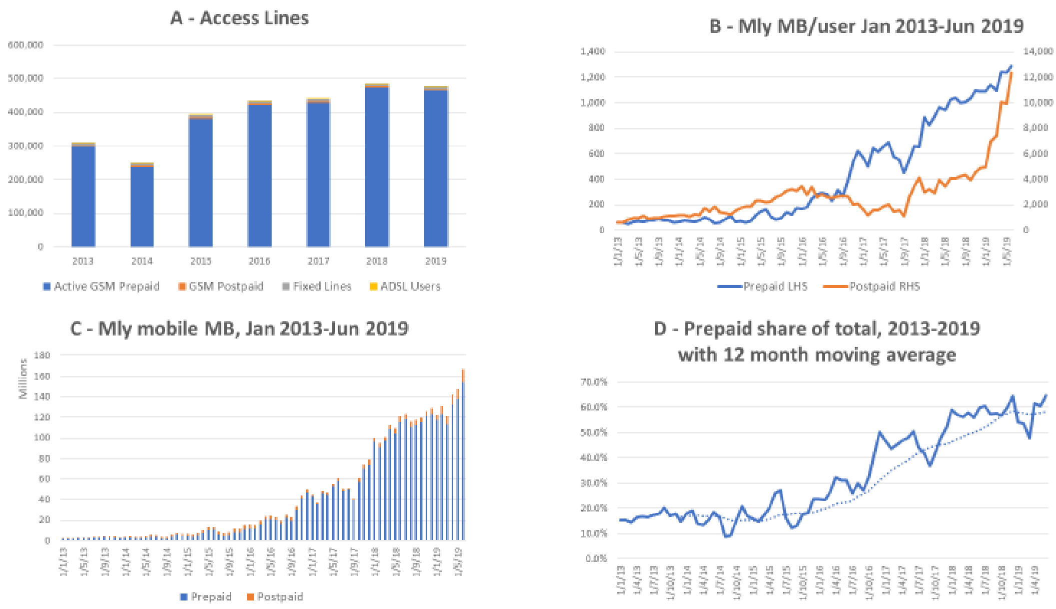
SISCC would like to get 4G or 5G (or its traffic equivalents) in the first year. Given that current international (satellite) capacity is only 0.2G, that is a big step. The SIG has indicated that it would commit to around 1G and there is probably pent-up demand that will be unleashed by the availability of (initially) up to 100G cheap, high quality, reliable bandwidth.

The focus of this report is on what mass market demand might be in 2024.

We start with a simple industry model based on TCSI data. This is followed by some sanity checks, consideration of elasticity effects and then risks and opportunities.

6.1 Industry model

The focus is on prepaid mobile data from which we can then extrapolate total downloads.

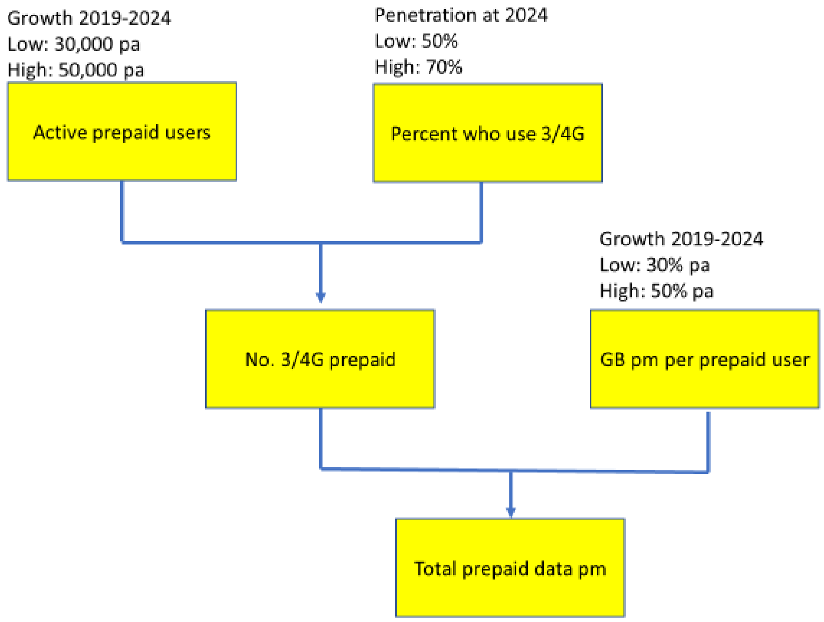


(Source: Abundance.ppt)

Chart A shows that prepaid mobile access lines dominate post-paid mobile and other access. Although post-paid GSM users are using 12GB pm compared with around 1.3GB pm for prepaid mobile dating using customers (Chart B), they are so out-numbered that pre-paid mobile volumes are about 10x larger than post-paid (Chart C). And, pre-paid mobile data has become increasingly important in total downloads (Chart D).

Assuming that pre-paid remains around 60% of total downloads (Chard D), we can use this to scale the pre-paid demand forecast to total downloads tracked by the TCSI.

The demand model is very simple and makes forecasts using some basic assumptions as shown.



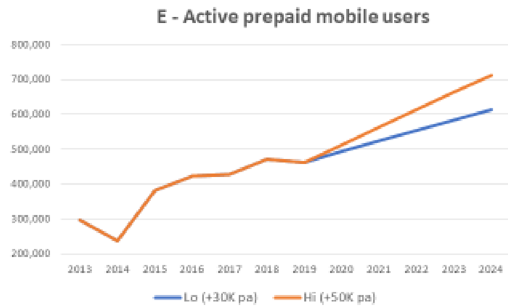
The two scenarios for active prepaid users is shown in Chart E below. Prepaid mobiles are currently about 68% of the population. The National Statistics Office sees the population growing 2% pa to 750,00 by 2024[39]. With annual increases of 30,000 or 50,000 in active prepaid mobile users, the mobile penetration rate in 2024 would be 82% or 95% in 2024 respectively.

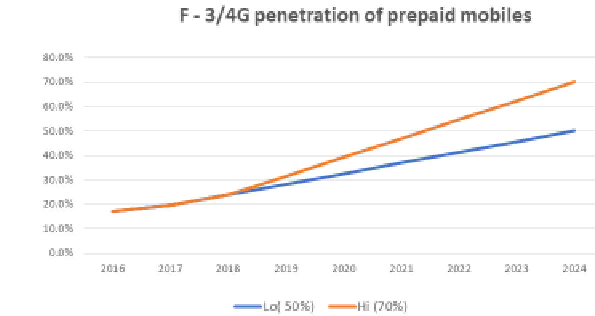
The important number for our purposes is the number of active prepaid mobile data users using 3G or 4G mobiles. Currently, data-capable mobiles are held by 25% of active prepaid mobile users. Chart F assumes this could increase to 50% or 70% by 2024. It depends upon the roll-out of 3/4G infrastructure and uptake of associated mobile phones.

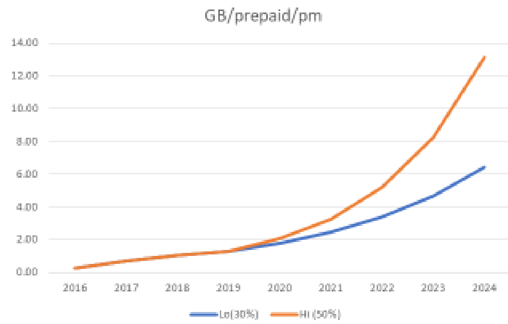
While prepaid mobile users download around 1.3GB now (Chart B above), it grew 66% pa between 2016 and 2019. If it now grows 30% or 50% pa, the monthly download will be either 4.8GB pm or 9.8GB pm by 2024 (Chart G).

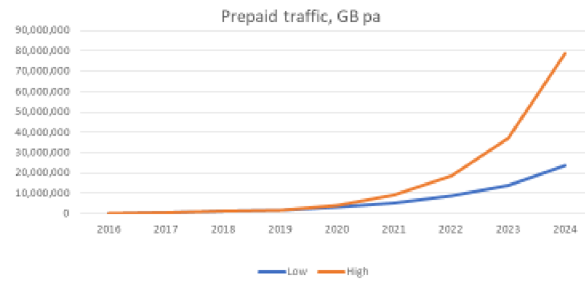
Multiplying the scenarios gives the prepaid mobile demand scenarios in Chart H (=E*F*G). Using the low scenario assumptions, demand is 17.6TB pa and with the high scenario assumptions it is 58.8TB pa. Elasticity effects will be added in Section 6.3.

[39] https://www.statistics.gov.sb/statistics/social-statistics/population



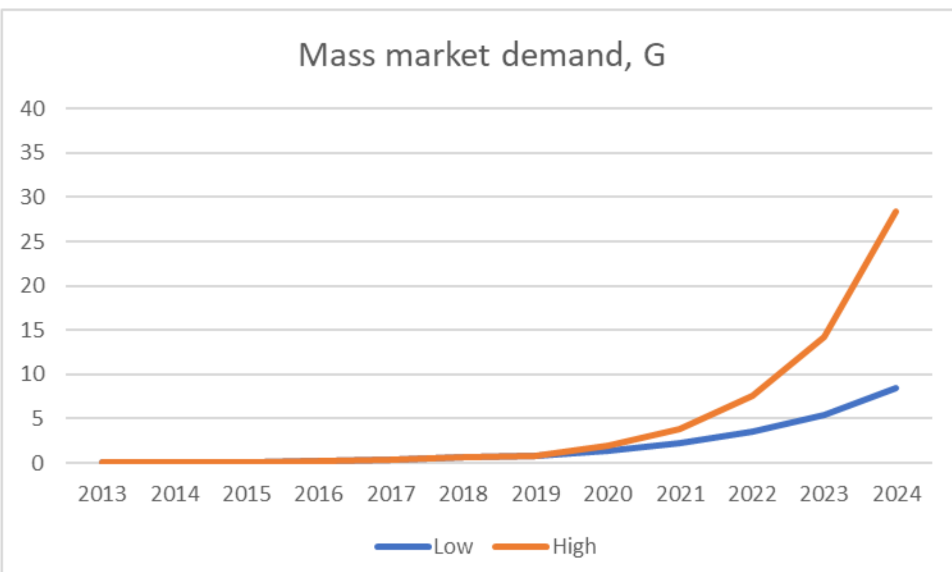






(Source: Abundance.ppt and Model/BBM workbook)

Applying the 60% scaling factor (Chart D above) gives total downloads of between 29.4TB and 97.9TB pa by 2024. The equivalent bandwidth capacity forecast is 8.5G to 28.4G[40]:



(Source: V100, Model/BBM workbook)

40 The chart does not include the Pacific Games in 2023 that should add some temporary demand leading into and during the games.

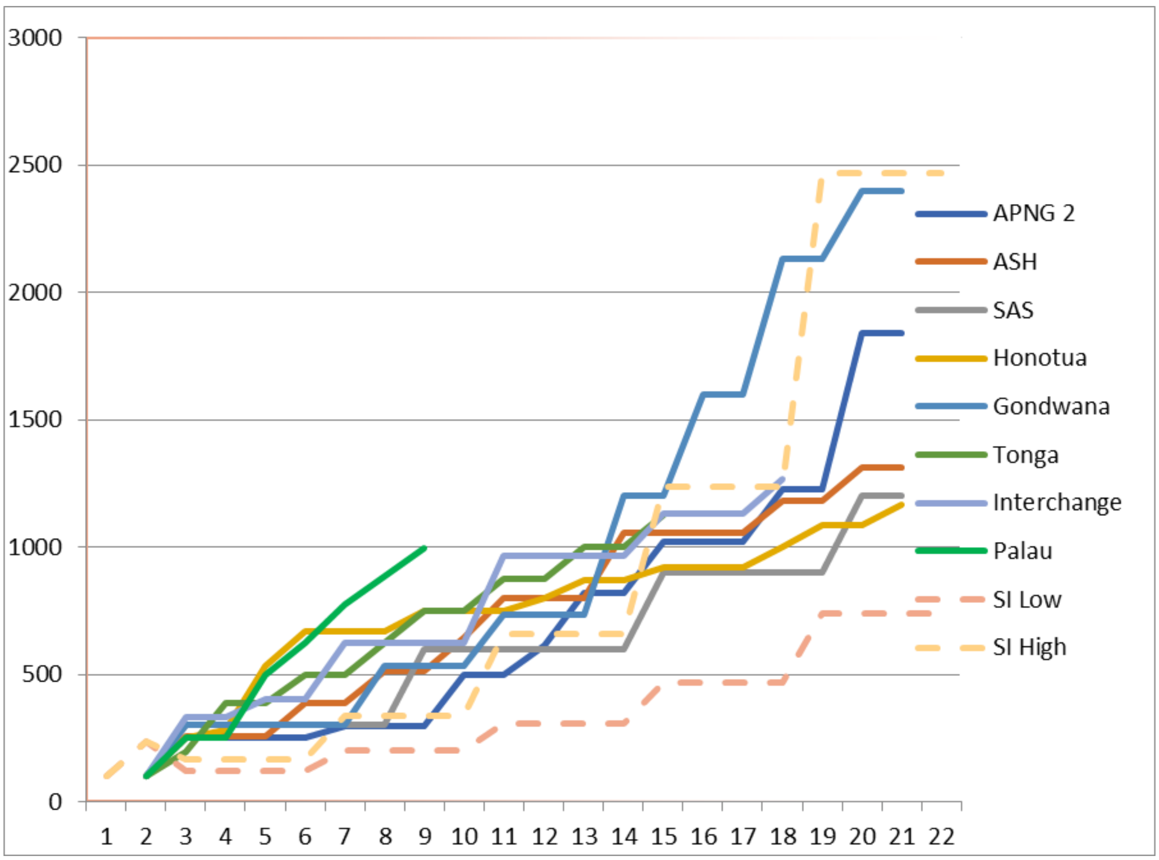
This is a wide range because the Low forecast combines all the most pessimistic assumptions and the High forecast combines all the assumptions that lead to higher numbers (Charts E to H).

The forecasts above do not include a traffic pricing effect. Usage based pricing with higher speeds inevitably leads to higher consumption. When clicking on something gets an instant result – you click more. Section 6.3 adds the elasticity impacts.

Another point to note is that the forecast for the Solomon Islands is based on only the data tracked by the TCSI. In PNG private lines accounted for about half international use of submarine cables. But PNG is a bigger country with more banks and corporations that might need international connectivity.

6.2 Sanity checks

The range is so wide that it brackets the take-up experience of other cable launches (see the chart below). SISCC kindly provided me with data on the growth in G demand by number of quarters from launch across a number of cables in the Pacific[41]. The Low and High scenarios are shown as dotted lines for CS2.



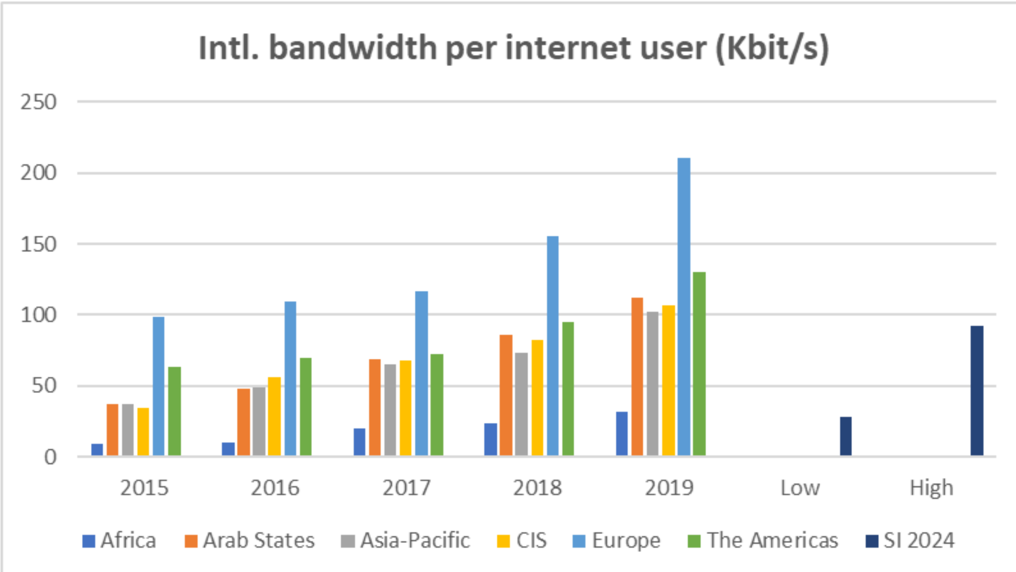
(Source: Pacific/BBM workbook)

[41] Workbook Pacific Capacity Growth May 2019

There are a couple of other ways to make international comparisons that can be used to test the two scenarios.

First, international bandwidth per internet user. The ITU collects this data as illustrated below[42]. The last two blocks show international mass market demand per active prepaid 3G user (probably close to total internet users – see Chart A above) in the Solomon Islands for the two scenarios at 2024.

Both scenarios for the Solomon Islands in 2024 are consistent with other regions' status today. But, the Low scenario seems too pessimistic. Demand could be higher.



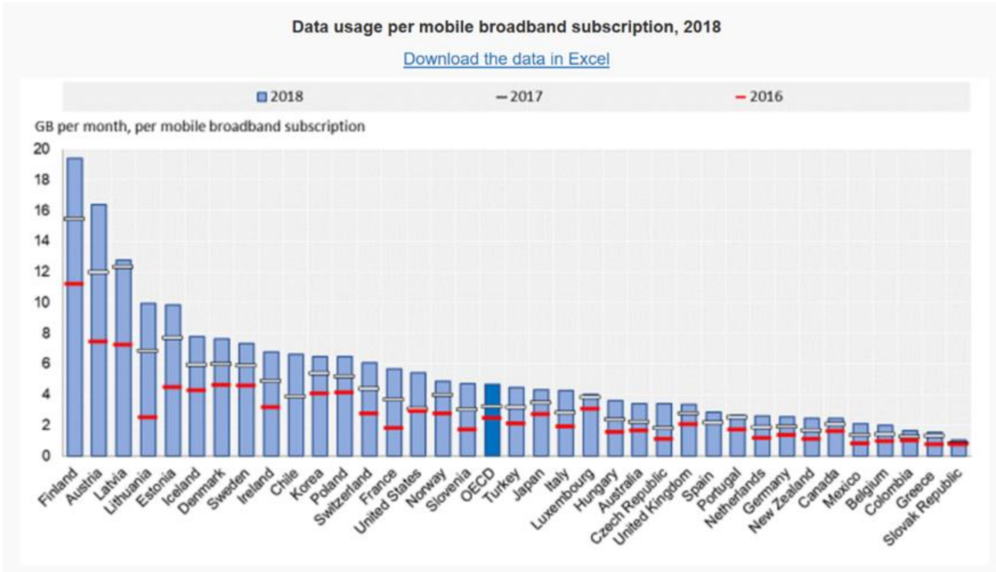
(Source: Model/BBM workbook)

The next test it to look at downloads per capita (GB/head per month). The chart below comes from the OECD[43] and shows mobile broadband GB per month. Greece was at 1.5GB in 2018 (double its 2016 downloads).

---

[42] https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx The ITU also collects data on lit capacity.

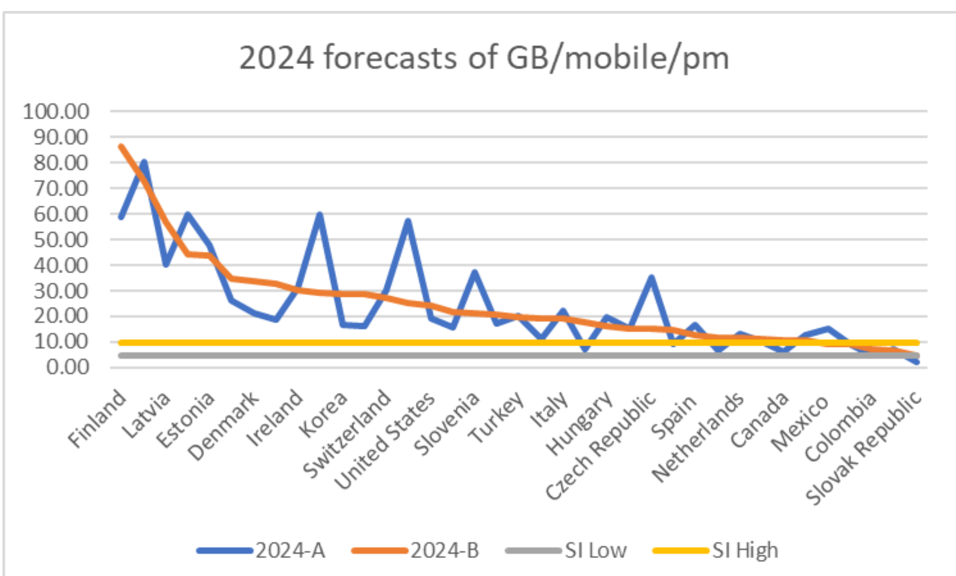
[43] https://www.oecd.org/sti/broadband/broadband-statistics-update.htm



(Source: OECD/BBM workbook)

The mean download for active prepaid 3G users in the Solomon Islands was 1.29GB pm in 2019 and has been growing 64% pa since 2013. The Low scenario grows at 30% to 4.8GB pm in 2024 versus the High scenario's 50% growth to 9.8GB pm.

That puts the Solomon Islands up with Estonia in the left of the chart above. But, that was 2018 and if we extrapolate using each country's own growth rate (2024-A) and the average growth rate (2024-B growing 28% pa), the Low and High scenarios for the Solomon Islands are reasonable:



(Source: OECD/BBM workbook)

Much depends upon action to improve local access bottlenecks; such as migrating to 3G/4G and connecting more fixed network customers. This can be done quickly using wireless instead of copper for the last mile and such converged networks are becoming best practice. Verizon for example:

"is in the process of converging many of its wireless and wireline operations, targeting the efficiencies to be gained from placing many wireless and wireline tasks under the same teams. …Most significantly, it is working on a converged core network, and looking to leverage the same fiber, as much as possible, to support consumer, enterprise and city broadband, as well as backhaul for dense urban networks and fronthaul for distributed RANs."[44]

6.3 Elasticity and traffic pricing effects

The price of domestic (SIDN) and international (CS2) will be significantly lower than existing options and as the benefits are passed on to end users, retail demand will be stimulated. At the same time, traffic pricing is expected to lower entry barriers and stimulate competition and innovation which will also put downward pressure on prices and stimulate demand.

Price elasticity is the percentage change in quantity demanded divided by the percentage change in the retail price. An elasticity of, say, -0.6 would mean that a 10% price decrease would be followed by a 6% increase in demand. This is the elasticity I used for work in PNG for PTSN price rebalancing (i.e. for call minutes). All the academic and public literature about price elasticities in communications focus on the demand for connectivity or minutes of use – not demand for bytes[45]. **Assume -0.6** for our forecasts for GB pm.

Next, we need know not only the size of cut in wholesale transmission pricing but also what will be passed on to retail pricing.

For the percentage change in international connectivity costs: one price I have for current satellite costs is US$222/Mbps on O3B. Another quote I was given was US$170/Mbps on O3B. The maximum price on CS2 is $99/Mbps which is 42 to 45% cheaper. **Assume 40%.**

The next step is to estimate the pass-through to retail prices[46]. The three ISPs in the Solomon Islands were asked what share of costs or revenues is accounted for by current (satellite) bandwidth costs (which would include domestic connectivity). One estimate

[44] Convergence and SDN are the heart of Verizon's bid to slash network costs. Rethink 30th August 2018

[45] For example: C. Garbacz and H.G. Thompson Jnr, Demand for telecommunication services in developing countries Telecommunications Policy Volume 31, Issue 5, June 2007, Pages 276-289 at https://doi.org/10.1016/j.telpol.2007.03.007

[46] In PNG, international wholesale pricing was cut 30% in one year on my advice and the Telikom retail pricing manager was going to pass this on as a 30% cut in retail broadband prices. I had to remind him that we had estimated international connectivity represented only a third of the retail cost structure for internet so that these prices could be cut only 10% without affecting margins.

was “25-30%” and another ISP’s annual report suggests around 20%. **Assume 25%**. That means **retail prices should fall at least 10%** (40% * 25%).

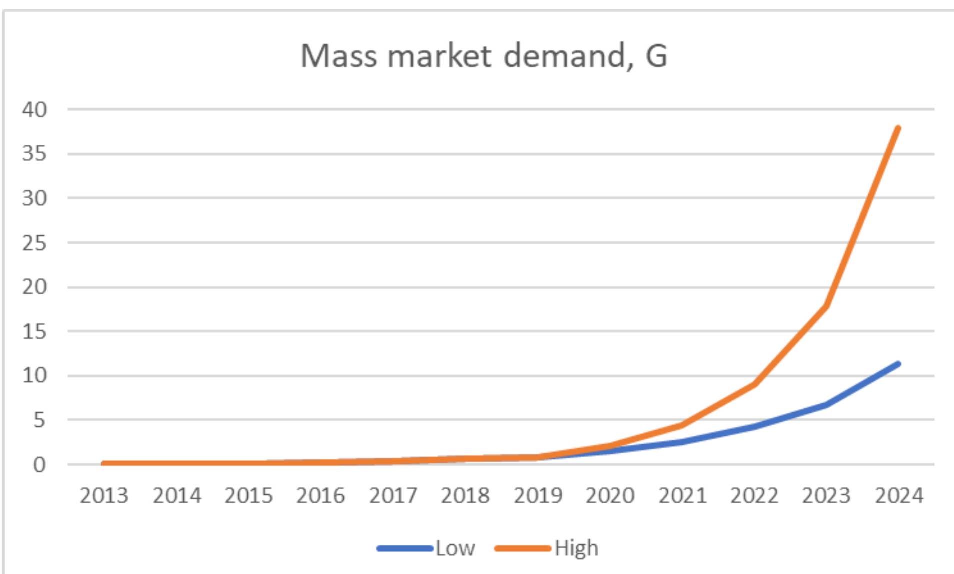
Applying the price elasticity of -0.6**, demand should increase at least 6%** as a direct result of cheaper international connectivity. Applied as a once-off boost to GB per prepaid 3G user, this leads to 9G (an extra 0.5G) in the Low growth scenario and 30.1G (an extra 1.7G) in 2024 for the High growth scenario.

But there will be more price cuts. This is not only because satellites and new cables will pressure on cable pricing (whether charged as bandwidth or with traffic pricing) but also because current retail broadband prices seem high and will fall with strong competition.

There are only two mobile operators in the Solomon Islands (Our Telekom and bemobile) plus Satsol providing fixed wireless internet and tv services. By lowering entry barriers through traffic pricing, more competition may emerge to put further downward pressure on retail prices. The existing operators could even promote this with resale and mobile virtual network operators (MVNOs)[47].

If retail prices continue to fall 10% pa, then the price elasticity takes Low scenario in 2024 to 6.4GB/prepaid user and mass demand for international bandwidth to 11.4G (the lower dotted line below) versus 8.5G with no elasticity and price cut effects.

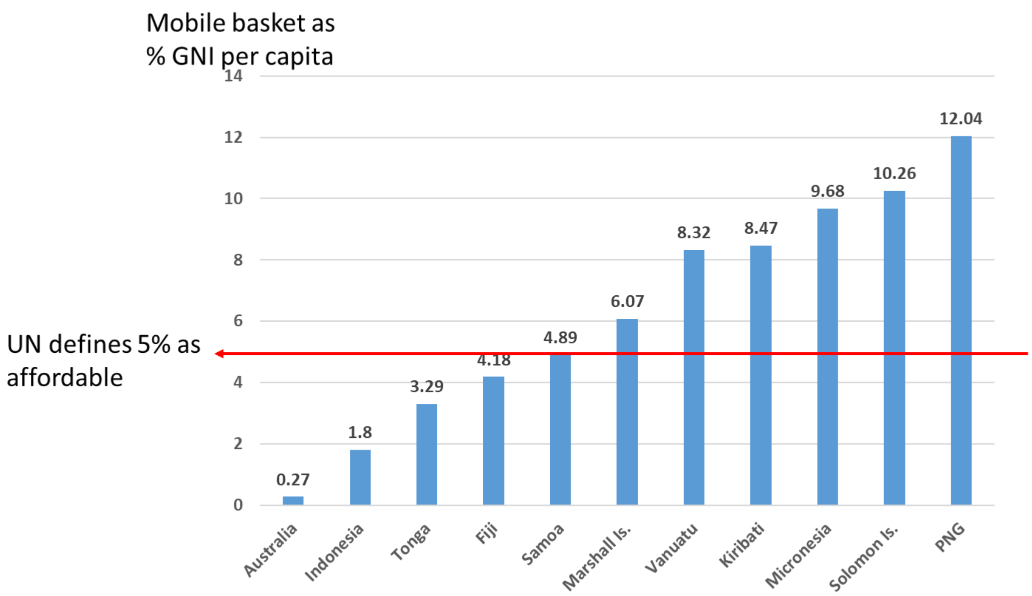
The High scenario usage with continued retail price falls of 10% pa and elasticity effects is 13.1GB/user pm and international bandwidth demand in 2024 of 38G (the higher dotted line below) versus 28.4G with no elasticity and price cut effects - an extra 10G by 2024.



(Source: F100 in Model/BBM workbook)

[47] There are only three mobile network operators in Australia but scores of MVNOs accounting for 13% of the market https://www.ventureinsights.com.au/product/australian-mvnos/

The Solomon Islands is a poor country which helps to explain why its mobile service is considered unaffordable by the UN[48].



Better broadband is also reckoned to increase GDP per capita so that will also help improve affordability[49].

6.4 Threats and opportunities

There are many factors which will affect the demand for international cable capacity:

- New and additional submarine cable capacity could arrive within 2 years
  - Our IT Consultant, Matthew Mann, has pointed out to me that the proposed ICN2 may actually increase demand for CS2 as this may provide a more attractive route to Sydney for Vanuatu than SXC.
- New LEO satellites RFS are expected in 2021
- Content caching locally will reduce demand for international capacity. Evidence from three overseas companies who cannot be named suggests that Netflix would have the biggest impact on cable demand:

  - Customer-A: Between 45% - 50% of total International traffic is being served from the local Google, Netflix and Akamai caches.

  - Customer-B: Between 25% - 30% of total International traffic is being served from just the local Google cache.

[48] Table 16, Broadband Connectivity in Pacific Island Countries, UN ESCAP, 2018

[49] See reviews of the literature by the World Bank and ITU respectively at http://pubdocs.worldbank.org/en/391452529895999/WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf and https://www.itu.int/en/ITU-D/Regulatory-Market/Documents/FINAL_1d_18-00513_Broadband-and-Digital-Transformation-E.pdf

- Customer-C: Between 55% - 60% of total International traffic is being served from the local Google, Netflix, Akamai and Facebook caches.

The impact of a local cache varies depending on the culture and consumption habits of Internet in the source country (i.e. low Netflix use will mean less cache impact).

Detailed Netflow traffic information was sought from the three ISPs to make an assessment of the current amount of traffic hitting Google, Netflix, Akamai and Facebook. Typically, this streaming traffic increases when a submarine fibre optic cable is adopted – and then falls with caching.

- The sparse and dispersed population of the Solomon Islands population makes the improvement of local access networks a difficult task
- The Solomon Islands is a poor country - affordability is a big issue

Given the assessments above, the mass market demand could be at around 15G (the mid-point of the scenarios including falling prices and elasticity effects) by 2024.

7 Viability of SISCC

SISCC is a new company owned by the Investment Corporation of the Solomon Islands (ICSI) with 51% of the share capital and The Solomon Islands National Provident Fund (SINPF) with 49%. It is therefore a 100% government backed company which owns and operates Submarine Cable services in the Solomon Island territory.

7.1 Costs

The CS2 cable is managed by a Special Purpose Vehicle owned equally by the Australian Government (DFAT), DataCo (PNG) and SISCC. The allocation of the (CAPEX) costs of these two cable systems is shown below[50].

	DFAT	PNG	SISCC	Total
CS2	92,056,757	19,648,300	19,613,293	131,318,350
SIDN	31,728,950		13,820,234	45,549,184

DFAT has paid for 2/3 of the CS2 from Sydney to the branching unit (BU) where the cable splits to go to Port Moresby and Honiara and it has paid 2/3rds of the cost for each of these links too. The numbers in the row for CS2 for PNG and SISCC include their equal contributions for the shared cable from Sydney to the BU (0.167% each) and 1/3rd of their respective final links.

[50] US$ as at 15 October 2019 (US$1=A$1.3)

SISCC will have its own accounting polices for deciding how to value the Indefeasible Rights of Use (IRU) it has for 2 fibre pairs for the full lifetime of the Cable system (25 years). But, economists and regulators value assets at depreciated, optimised, replacement cost (DORC) which in the case of the new cables are simply the numbers in the final column above. The idea is that pricing to recover DORC will ensure that the asset can be replaced when it wears out[51].

Making the heroic assumption that DFAT (or some other benefactor) would pay 2/3rd of the cost of replacing CS2 when it wears out, the replacement (DORC) cost that SISCC has to recover is just $19,613,293 (the same as its equity). If PNG and SISCC have to pay for a replacement cable, then SISCC should be planning to recover $65,641,672 (=$19,613,293 plus half of $92,056,757).

The wholesale revenues which a regulator would allow SISCC in order to recover costs are determined by the building block model:

WACC	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%	15.0%
		2019	2020	2021	2022	2023	2024
Opening RAB (DORC) excl SIDN		19,613,293	19,613,293	19,028,761	18,444,230	17,883,079	17,345,310
Less depreciation	25	0	784,532	784,532	761,150	737,769	715,323
Add new investment		0	200,000	200,000	200,000	200,000	200,000
Closing value of RAB		19,613,293	19,028,761	18,444,230	17,883,079	17,345,310	16,829,987
Wholesale revenue requirement:		2019	2020	2021	2022	2023	2024
Depreciation	Block 1	0	784,532	784,532	761,150	737,769	715,323
Return on assets	Block 2	0	2,941,994	2,854,314	2,766,634	2,682,462	2,601,796
Total OPEX	Block 3	0	3,550,217	3,796,668	3,805,310	3,453,365	3,561,914
Tax (30%)	Block 4	0	0	0	0	0	0
Wholesale revenue requirement		0	7,276,743	7,435,514	7,333,095	6,873,596	6,879,034

(Source: Lo excl SIDN/BBM workbook)

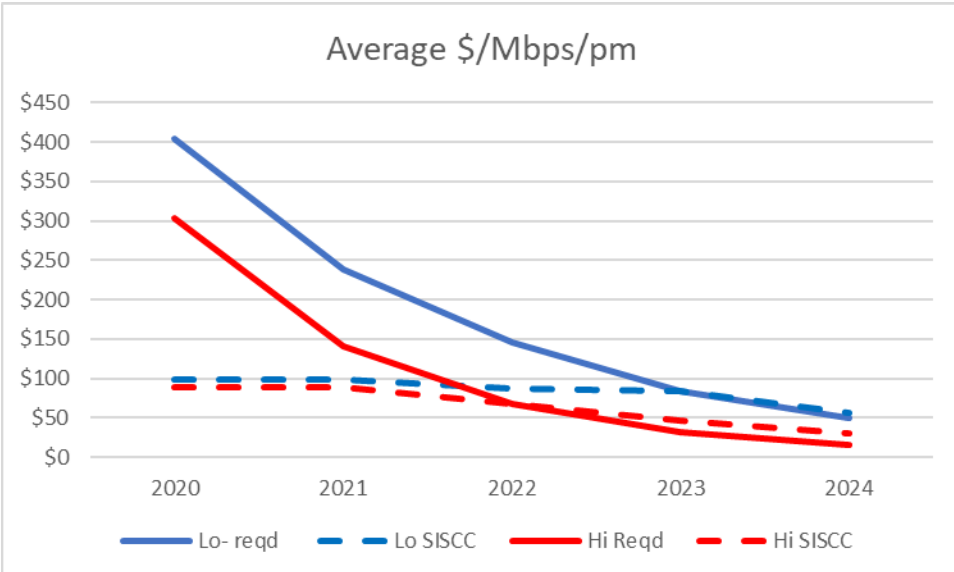
The opening value of the regulatory asset base (RAB) is the DORC which is equal to the Solomon Islands equity in CS2 as discussed above. The asset base is then rolled forward subtracting depreciation (straight-line depreciation over 25 years) and adding new investment (from SISCC plan).

The weighted average cost of capital (WACC) of 15% is, in my view, conservative. An appendix to this report shows it could be higher.

[51] CS2 will replace PNG's aged APNG cable.

Operating costs (OPEX) are taken from SISCC plans.

The sum of the four blocks is the allowable wholesale revenue for CS2. It does not change with demand. But the cost per Mbps depends upon the level of demand. The solid lines in the following chart show the required revenue divided by each of the demand scenarios and the dotted lines show SISCC revenues divided by the corresponding demand scenarios.



(Source: Cell C57, Lo excl SIDN/BBM workbook)

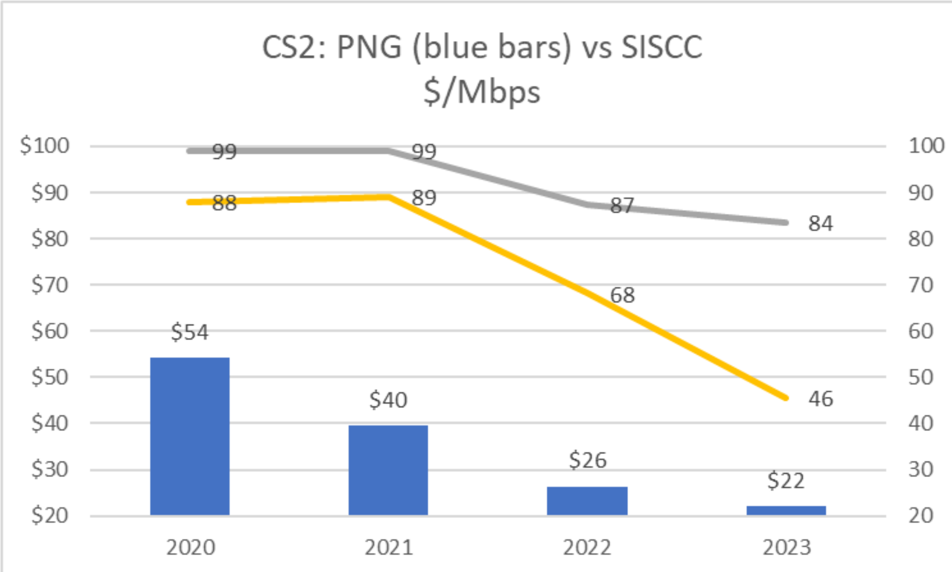
Lo required	$404	$238	$145	$84	$50
Lo SISCC	$99	$99	$87	$84	$56
Hi required	$303	$141	$68	$32	$15
Hi SISCC	$88	$89	$68	$46	$29

7.2 PNG and CS2

In PNG, its regulator, NICTA, has just set prices for CS2[52]. The initial price for CS2 is $54/Mbps (K185/Mbps). DataCo had planned to cut the price of international connectivity to Sydney from $179/Mbps to $98/Mbps (similar to the Solomon Islands) for a 1 Gbps connection in January 2020.

The costs of CS2 for PNG and the Solomon Islands as viewed by a regulator must be similar. So the maximum prices set for PNG are probably too low because it is difficult to see how the level of demand in PNG could lead to the prices compared below with the Solomon Islands on our two demand scenarios (the upper line is the Lo scenario):

[52] https://www.nicta.gov.pg/2019/07/cp-0-7/



(Source: Charts/Pricing workbook)

7.3 Policy and governance

There are a couple of issues that could be addressed to make life for SISCC and its stakeholders easier.

First, the SIDN has not been included in the costing model above because it is a heavy burden on SISCC. Naturally, it should operate the SIDN and cover operational costs of doing that. But SISCC should not be expected to replace it or make a return to its shareholders on this asset. **The asset value for the SIDN should be taken off its books.**

It is the right of politicians to make uneconomic investments for social and economic development reasons. The commercial business case for the SIDN does not stack-up:

- First, the SIDN is not viable for a commercial operator. Country areas like the provinces in the Solomon Islands are usually uneconomic. A provincial network needs to be supported with grants and/or cross-subsidies that cannot be by-passed.
- Second, there is market failure because many of the social and economic benefits for the Solomon Islands will not be seen in the private business case. The corollary of such benefits ("*externalities*") is public subsidy and support.

The public business case for the submarine cables is that everybody benefits as broadband changes the way we do business.

Second, SISCC's charter – or a SIG "*Statement of Expectations*" – should make it clear that it is not expected to be commercial. It is an arm of social and economic development policy. Some of this seems to be contemplated in the national ICT Policy "*To make* *information and communications technologies available, affordable and accessible to all in Solomon Islands"*[53] and the emerging Digital Transformation Strategy.

This puts the SI National Provident Fund (SINPF) is in a difficult place as it must satisfy shareholders that SISCC is a commercial investment. On the other hand, low international capacity prices are good for its 97.32% stake in the incumbent retail operator, Solomon Telekom. **It is conflicted. Only making the expectations of the SIG for SISCC clearer and enabling the SINPF to exit SISCC can resolve this**.

Whatever the doubts on the commerciality of SISCC, the Solomon Islands still benefits from the new submarine cables. A good analogy is a new highroad linking two towns. It had to be done but traffic is not as high as expected because new refrigerated and other warehouses reduce the need to truck supplies. The submarine highways built by the Solomon Islands with the generous support of the Australian Government are not too big. **Submarine capacity comes only in one size: VERY BIG.**

The fact that submarine cables are not filled is not relevant. They were needed and they also enable the local hosting of content even though this subtracts from the demand for the international cable. Without the cable there would be no local hosting of content and all the benefits that flow from that.

Lastly, the SIG can help encourage infrastructure sharing (e.g. domestic fibre and towers), waive 30% duties on ICT imports and (as it is doing) use its own demand to promote the use of the submarine cables.

[53] National ICT Policy, 2015

Appendix 1 – Excerpts from the Act

Part 8 (Competition) of the Telecommunications Act (2009) has some important sections relevant to this report.

On "***One Desk***" these sub-sections of Section 60 are relevant to SISCC:

(c) prevents or restricts the supply or acquisition of a telecommunications service to or from a person or class of persons;
(d) requires or unfairly induces a supplier to refrain from selling to another service provider;
(e) imposes unfair restrictions on whom another person may deal with in a telecommunications market;

On the **bundling of IP Transit** (my addition):

60(2)(i) - *bundles a telecommunications service* (IP Transit) *that is supplied in an effective competitive telecommunications market with a service that is not supplied in an effective competitive telecommunications market* (CS2) *in circumstances where a discount* (free or below cost IP Transit) *is applied to the effectively competitive service sold as part of the bundle and such discount is not available if the effectively competitive service is acquired on its own;*

On the **lumpy capacity purchases** with bandwidth pricing:

60(4)(b) - *does not afford a person engaging in such practice or entering into such contract, arrangement or understanding the possibility of eliminating competition in respect of a substantial part of the telecommunications services in question.*

63(2)(d)(i) – *do not unfairly discriminate among service providers*

Appendix 2 – The WACC

In cost models, the weighted average cost of capital (WACC) is used to calculate the return on capital, with the expected cost of equity estimated using the capital asset pricing model (CAPM).

The formula for the WACC is: $WACC = (E/V * Re) + (D/V) * Kd * (1 – \text{Tax rate})$
And the CAPM formula is: $Re = Rf + \beta(Rm – Rf)$

Where:
E = Equity
V = Total capital = equity plus net debt (E+D)
D = Net debt
Re = Expected return on equity defined in the CAPM formula above
Kd = cost of debt
Rf = the risk-free rate such as the US 10 year government bond rate
β = the equity-beta measuring risk relative to the market
Rm = Expected market rate of return

V = $26,731,861 according to the SISCC financial plan, of which
E = $22,564,597 in 2020 (E/V= 84.44%) so that
D = $4,167,354 (D/V = 15.59%)

Rf = the risk-free rate is often taken to be the yield on US 10-year Government Bonds because the value of this type of security is extremely stable and a certain amount of profit is guaranteed. Over the last five years, the 10-year bond has averaged a yield of 1.92% [54].

The application of the CAPM formula to derive the expected return on equity for the Solomon Islands is difficult as the financial market is too small to measure things like the equity beta and expected market rate of return. Adjustments need to be made to the CAPM where asset returns are not well correlated to world returns and there is country risk.

A world expert on country risk is Aswath Damodaran[55]. His approach is to start with an equity risk premium for a mature market (such as the United States) and estimate additional risk premiums for riskier countries like the Solomon Islands:

[54] See https://au.investing.com/rates-bonds/u.s.-10-year-bond-yield
[55] See *Country Risk: Determinants, Measures and Implications - The 2018 Edition* at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3217944

Equity Risk Premium = Base Premium for Mature Equity Market + Country Risk Premium

At January 2019, the risk premium (Rm-Rf) for the Standard & Poor 500 in the US was 5.96%. The simplest and most widely used proxy for the country risk premium is the credit default swap (CDS) spread that investors charge for buying bonds issued by the country[56].

That default spread is not available for all countries. But a Moody's credit rating is available for every country; The Solomon Islands rating is B3. And, some countries that are rated B3 do have default spreads so the Solomon Islands can be mapped against these. In the Damodaran database[57], B3 is currently 734 bp (i.e. the rating-based default spread is 7.34%).

Intuitively, we would expect the country equity risk premium to be larger than the country default risk spread. To address the issue of how much higher, Damodaran looks at the volatility of the equity market in a country relative to the volatility of the bond market used to estimate the spread. For the Solomon Islands (and other countries) Damodaran uses the emerging market average of 1.23 (estimated by comparing an emerging market equity index to an emerging market government/public bond index). This factor of 1.23 does exactly the same job as the equity beta β discussed earlier. So, now, our CAPM for the Solomon Islands says:

Re = Rf + β(Rm – Rf)
= 1.92 + 1.23*(5.96 + 7.34) = 18.28% using the Damodaran database

Kd = The SISCC financial plan assumes an interest rate of 8.5%. However, the official lending rate is 10.47%[58]

Tax rate = 30%

Applying the above to find the WACC:

WACC = (E/V * Re) + (D/V) * Kd * (1 – Tax rate)
= (0.8444*18.28) + (0.1559*10.47*(1-0.3) = 16.58%

[56] The price of a credit default swap is referred to as its "spread," and is denominated in basis points (bp), or one-hundredths of a percentage point. For example, if a Citigroup CDS has a spread of 255.5 bp, or 2.555%. That means that, to insure $100 of Citigroup debt, you have to pay $2.555 per year.
[57] http://www.stern.nyu.edu/~adamodar/pc/datasets/ctryprem.xls
[58] http://www.cbsi.com.sb/ November 2019, accessed 12 January 2020