Factors affecting end user experience in the Internet Environment

1. Possible Contributing Factors to Slowness in Access Speed

1.1 Local Content

In general, local content refers to content hosted within Singapore. The webservers in the example diagram (Appendix A), are representative of content providers.

Webservers' Performance

Different webserver types used for hosting content, depending on its technical specifications, could lead to varying end-user experiences. For example, webservers configured with high-powered central processing units and huge amounts of memory would have superior serving capability, compared to those that are minimally configured. Depending on the type of content provided (eg. streaming content), different processing power is also exacted of the server. In addition, server solutions that are coupled with intelligent management software could enhance the end-user experiences.

Nevertheless, high-end servers could still be overloaded during peak times when the number of concurrent accesses exceeds the webserver's capability. Some end-users may therefore be denied access whilst others may experience a degradation of speed due to heavy processing at the webserver's end. The economics of providing multiple servers would then be an issue for the content/service provider to address.

Siting of webservers

Typically, webservers are hosted on the backbone of networks to facilitate the delivery of content. In the event where the webserver is hosted at a remote site (e.g for security / management purposes), a leased line connection is required to a network service provider. In this case, the catered bandwidth of the leased line becomes the bottleneck if users are demanding more bandwidth than available capacity.

In addition, if access to content is made across an interconnection of various network providers (e.g at SingNet instead of 1-Net as indicated in Appendix A), the interconnect bandwidth catered between the network service providers and the loading of their routers could also be potential bottlenecks.

1.2 International Content

In general, international content refers to websites hosted overseas. User experience in accessing such sites will not only be affected by similar factors as discussed above, but also the amount of international bandwidth catered between Singapore and the destination country overseas. In addition, the domestic traffic routing policies at the overseas end is also important in the determination of user experience.

To illustrate, a diagram which typifies the complex Internet environment in the United States is provided in Appendix B. Primarily, the diagram shows that depending on where the destination server is, an end user in Singapore will have different experiences. Evidently, content behind different leased line speeds and at different tiers will have different effects on end user experience. Coupled with the domestic routing policies at the overseas end and the extensiveness of the interconnectivity between the networks, a packet may be taking a less than optimal path.

In addition, where the international bandwidth is provisioned via a satellite path as opposed to a submarine/under-sea cable, the end-user experience may also be different. Typically the inherent latencies are about 200ms for cable and 500ms for satellite depending on physical and technical factors.

1.3 National Backbone for Broadband Internet

In the context of broadband Internet, the national backbone refers to the entire interconnection of networks belonging to the:

1. Local Access Network Providers (e.g SingTel and SCV)
2. Core Network Providers (e.g 1-Net)
3. Internet Service Providers (e.g StarHub Internet and SingNet)
4. Internet Exchange Providers (e.g SingTel Internet Exchange)
5. Others (e.g Content Hosting Providers, Content and Services Provides)

Please see example diagram in Appendix A.

In addition to the factors discussed above, there are a few other considerations worth noting where end-user experience is concerned:

Domestic Routing

In certain cases, Internet service providers do not route traffic between each other domestically. The result is a sub-optimum situation where traffic is diverted to international pipes and is routed through the Internet to reach the other domestic Internet service provider. The latency experienced by an end-user would thus be greatly increased.

Firewalls and Security

Where security features are installed in a network, the examination and filtering of packets with every additional layer of firewall may decrease effective throughput.

Technologies – Access networks

Finally, because of different technologies deployed in the broadband local access networks, a cable modem user's experience could potentially be very different from an ADSL modem user's experience. As illustrated in the diagram in Appendix A, the 'tree' configuration of the cable network indicates the use of a 'bus' type of technology where users contend for bandwidth at the

last mile. Hypothetically, if 10 users out of 1000 which a CMTS(cable modem termination system) is serving (with typical maximum downstream capability of about 30 Mbps) demanded constant streaming of 1.5Mbps (typical of a MPEG coded video application) each, the remaining 900 users will then have a total of 15Mbps, which may be insufficient, depending on the pattern of usage. This is different from a dedicated bandwidth per user in the ADSL environment.

2. **Consumer's Perception of Speed**

One other important parameter in the equation of end user experience is the relative perception of speed of various end users. For example, a speed of 150 Kbps (about 3 times quicker than a 56Kbps dial up modem) may seem perfectly fine to some but totally unacceptable to others, depending on the differing expectations of speed of download and access of various end-users.

3. **Possible Improvement**

Singapore can still, within our scope of control, proceed to enforce a generic framework that seeks to improve the quality of the Internet environment within Singapore and hence the end-user experiences. The framework must be built around an appreciation of the mentioned issues and any other relevant factors not discussed above, to ensure that it is not only commercially and technically feasible, but fair and acceptable.