

GOOD ENOUGH FOR SERIOUS POKER?

Network architectures will undergo dramatic changes over the next decade. The pandemic has triggered an abrupt increase of network use for virtual conferences, remote education, business negotiations, medical consultations and other usages including contact tracing. There is likely a new normal post-pandemic with networking playing a very key role. I would like to discuss the potential influence of the pandemic on the technical research and development of networks. This month is part one to be followed by part two next month.

There are a number of existing platforms that support virtual conferences and education events. Some have simple basic conference and sharing functions, while at the other end of the spectrum, there are platforms that allow virtual reality experiences such as strolling and exploring rooms, even interacting with the occupants of the rooms or communities of interest. The ultimate experience is a recent demonstration I participated in: a tennis match where the field of view was almost 360 degrees at high resolution and the total delay (network and processing) was very low to provide realistic interactions. That required 80Gbps connections! The technical question is: "How much data rate is enough?" The following is roughly the order of magnitude of the requirement on network speeds:

1. ~10Mbps for low end video conferencing (education minimum).
2. ~100Mbps for multiple-party high end conferencing (low-end business).
3. ~Gbps for interactive virtual reality (almost good enough for business).
4. ~100Gbps for almost there interactive experience (substitute to being there).

When I was forming the "All-Optical-Network" Consortium among MIT, AT&T and DEC in 1989, the Senior Vice President of Research at Bell Laboratories asked me the following question (they were trying to sell 1.5Mbps to businesses at the time): How much data rate is required for serious business negotiation? I did not directly answer in terms of the data rate requirement because I knew at the time there is much more than data rate that is necessary. I gave an example as the answer. I told him: "When the video, audio and application platforms are good enough to play serious poker with!"

If you are a serious poker player, you know that poker is not just a game of chance but involves, in complicated ways, human interactions and subtle behavior sensing, decision and signaling (truthful and fake), etc. If I have to translate virtual serious poker into network requirements they may look something like this:

1. Wide field of view (almost 360 degrees) high quality video.
2. Three dimensional sound field (>Gbps).
3. Low delay (<80ms).

Wide field is necessary because peripheral vision is used to monitor changes of human postures and expressions. These observations often are cued by audio. To resolve the direction of the audio cue the sound system needs to have what is known in the audiophile community as a three dimensional sound field and directional coherence such that the angle of sound arrival can be associated with a 3D location of the video. The existing audio format that barely satisfies this requirement is SACD, super audio CD, that uses five channels at 2.4Mbps (96Ksamples/S, 24bits per sample) per channel for a total of 12 Mbps. For low phase distortion reproduction, some processors use 128X oversampling which makes the total rate to be well over a Gbps/channel.

In the current infrastructures there can be a number of data rate choke (congestion) points: network pipes, routers or server I/O



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rates. The low and intermittent delivery rate can result in low display resolutions, freeze frames and/or application crashes. A straightforward solution but naïve approach is over-provisioning which is much too costly. The alternative, cross domain dynamic orchestration allows coordination of all network layers including applications and will increase utilization of network resources. However, the control plane of an orchestrated network needs to be more intelligent and agile for the delivery of time deadline services, service quality and policy driven routing dictated by policies, regulations and pricing. Moreover, policies, regulations and pricing are not just technical issues but social-economical ones.

The Internet is the backbone infrastructure of the current information age. Access to networks is essential to full participation in this society and the economy. Lack of universal access will create information haves and have-nots. This kind of division is dangerous and will lead to a widened spread in wealth, well-being and eventually give rise to social unrests and political instabilities. This threat has always been lurking in the background as profit-driven rapid employment of networks took place over the last two decades.

While in normal times, the effect of the so called "digital divide" may take years to show up, the current pandemic has greatly accelerated the time scale of its manifestation. A prime example is that the pandemic-triggered move to remote classes for education has accentuated the gulf between the rich and poor. Well to do families have broadband access but many low income families do not. They might have a smart phone with a limited data plan. The same video-based programing as viewed by different devices offers vastly different experiences and results. Over a prolonged period (as short as six months) this will further widen the gulf between the rich and poor and it can be hard for the disadvantaged to catch up later in life. They may even be unfairly labeled as "intellectually inferior" solely because of poor or no access to educational materials! Education may not be the ultimate equalizer anymore. A policy of universal broadband access should be established and enforced by government with public funding, similar to the "universal MaBell" phone access case in the 1950s. There have been debates on whether the future Internet should use content based routing/charging or practice net-neutrality (the principle that Internet service providers must treat all Internet communications equally, and not discriminate or charge differently based on user, content, website, platform, application, type of equipment, source address, destination address, or method of communications [wiki]). Content-based networking and services will be required to keep educational program deliveries at affordable cost (albeit at the expense of higher costs for other services). Profit driven market forces will not guide the development of the Internet to the desirable solution and thus government regulations, policies and outcome driven pricing are needed. The country of Ireland has just decided to provide 150Mbps access to all families, an addition of five hundred thousand homes. How can the Irish do it technically is not the important question. Most of us know how; it only takes money. Why they do it is the right question. What do they see is the imperative? Why should public funds be used to subsidize such services? What would happen if they do not do this? What will Ireland look like in the future with or without such commitments? What arguments did they use to get it passed in the legislature and convince the public to support it? Why shouldn't the rest of the countries around the world do the same thing? Do we have different values and sense of civic responsibilities?

More in part two next month.