CS 125: Computer Networks
Abstract 8

TCP/IP In Space

→ Is TCP/IP the best approach, after all the protocols are not 'bit' conservational?

→ What aspects of the TCP/IP protocol suite are applicable to space communication?

Sources

http://www.vsat-systems.com/Education/Satellite-Internet-Explained/Performance/Protocols-and-applications/


http://www.hackingtheuniverse.com/space/space-exploration/tcpip-for-space


https://www.nasa.gov/home/hqnews/2008/nov/HQ_08-298_Deep_space_internet.html

TCP/IP protocol stack allows data to be exchanged between 2 host in a relative reliable, stable way with low-latency. Data is split in packets, those packets can be fragmented before being thrown in the network then they will be reassembled by the destination host. So most of the work isn’t to reassemble those packets but to have packets to assemble, meaning that all that matters is to have a network able to convey the data. In order to achieve that we have put years of work to find the best medium (copper wires, air, fiber optics, etc.) to convey the data, the smartest protocol on each layer to send the minimum amount of data that still holds the essential information without sacrificing speed and reliability coupling that with networking strategy on delay, bandwidth and you end up “mastering” each sub-parts of what makes a network work.

While this has been done in a robust way for years on Earth because we have mastered our environment, space communication suffers from high operational cost, a rude environment that includes periodic sun-availability for the satellites, solar flares and all radio communications drawbacks such as line of sight but scaled to space problems. Making a protocol from scratch would cost a lot so most of the engineers working in space communications tries to adapt TCP/IP protocol applications to this wild environment to come up with a smart architecture. An IRTF group called Delay-Tolerant Networking Research Group (DTNRG) works on this issue knowing that end-to-end connectivity couldn’t be assumed; they working collaboratively with NASA and other companies from that sector.

On 2008, NASA came with a new TCP/IP-based protocol called DTN that stands for Disruption-Tolerant Network. In this protocol, nodes retain, cache data until one of the next node send them a confirmation that data has been well received to proceed to the next transmission. This way reliability is increased while back-and-forth is minimized, looking like a store-and-forward inspired concept.
Questions

→ Is TCP/IP the best approach, after all the protocols are not 'bit' conservational?

As what matters here is the network layer and transport layer functionalities, I think using UDP over TCP is a bad idea as it implies a lot of retransmission hence driving the cost of the communication up, and using other transport protocol... which ones? RDP is just TCP without segmented data...

Same for IP, I see no other candidates here, ATM is abandoned, so I think this is why everybody was working a set of TCP/IP extensions which is the most robust protocol suite we have for now as a strong basis, plus it's more an architectural-related problem (latency, delay, link drops) than a pure protocol one.

→ What aspects of the TCP/IP protocol suite are applicable to space communication?

To me this pictures summarize the strength of using TCP/IP, sources and destinations are still bind by this idea of “session” between them while the retransmission is controlled by the following node.

Sources awaits those ACKs before firing following packets, and I found this work well with the window concept, as we might want to send as much data as we can while the link is up, but I think that a time-out or a 3 duplicate ACKs won’t result in decreasing the window like we do on earth but on a reset of the window size to its lowest value, waiting that ACK from the node to start up again. This way it still limits the back-and-forth to its minimum while sending as much data as we can pulling down the cost of the communication.