The Real Story of OSI (with a large slice of Internet)

Many authors have related the tale of the early years of the OSI model and the disputes as to exactly which functions should be assigned to each of the layers. None has felt able to reveal the true story of love and passion that finally swung the argument the way of the model that has become so well-known. Now that so many years have passed, we feel it is time to set the record straight.

1. Ursula, Umberto and a donkey

Way back in the 1960s, at the dawn of peace, love and packet-switching, Ursula and Umberto fell in love. They lived in two villages on the island of Physicalia separated by miles and miles of dangerous mountain tracks. The social mores of the time, not to mention the dangerous mountain tracks, meant that the lovers could rarely meet. Their love and happiness was saved by a donkey called Medium and an enterprising French émigré called Daniel Le Framer.

Ursula and Umberto

2. Daniel's big idea
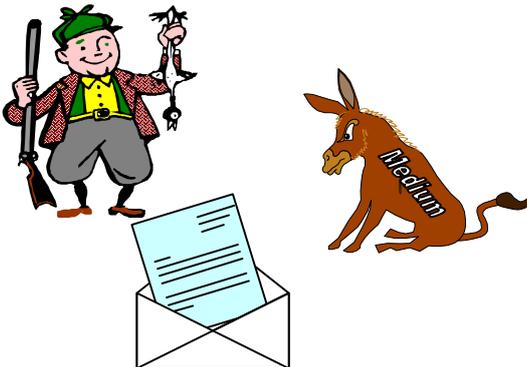
Daniel, the donkey and a "DL-Frame"

Medium was Daniel's donkey and was able, and occasionally willing, to negotiate the dangerous mountain tracks. Inspired by Ursula and Umberto's plight, Daniel invented the "D LeFraming Service". He made some envelopes which he marketed as "DL-Frames". Umberto and Ursula could purchase these envelopes, place a letter inside and ask Daniel to deliver them. Daniel did so, making use of Medium to carry the DL-Frames to their destination. Whilst Daniel's service was not 100% reliable (occasionally DL-Frames did go missing) it proved popular with Ursula and Umberto.

The picture below shows how Daniel presented his service to his customers. Notice how he decided to conceal the donkey. Perhaps he felt that the obstinate beast would detract from the high-tech image of his service, perhaps he had heard inklings of a nascent animal rights movement; we can only speculate.
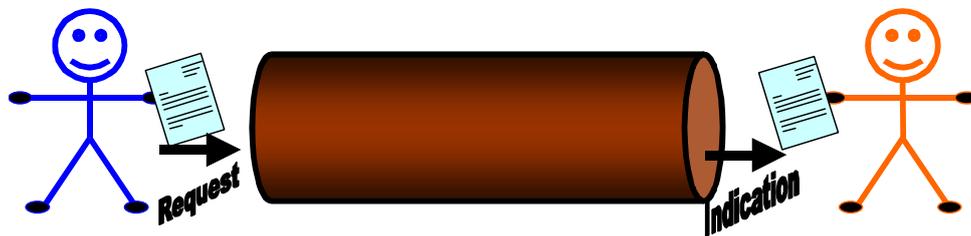
The DL-Framing Service. "You request, we indicate!"

Umberto and Ursula were quite happy with the DL-Framing service but they did get a little cross on the occasions when their messages were not delivered. (Daniel suspected that Medium occasionally supplemented his meagre diet by consuming DL-Frames but he kept this to himself.)

Daniel decided to offer Umberto and Ursula an enhanced service. It turned out that, whilst Daniel lived close to Umberto, his brother, Dominic, lived close to Ursula. Daniel decided to employ Dominic to help him implement the new service. He began to write numbers on the letters he sent and asked Dominic to check these carefully. He also kept a copy of each letter in case Medium should lose one. Daniel and Dominic invented some rules – a "protocol" they called it. For example, when Dominic received an envelope marked "6" he had to send an envelope back to Daniel marked "I've got 6". If the sequence of numbers was broken then Dominic did not send an acknowledgement. After a couple of days, Daniel would send another copy of the missing message. Daniel and Dominic now had a DL-Service with **error control**!

Dominic discovering a transmission error.

Sometimes Ursula went away to visit her mother in another village. When this happened Dominic was unable make deliveries and his house began to fill with envelopes. Dominic and Daniel added extra messages to their protocol. Dominic could now write, "I've got 6, but send no more!". Later, when Ursula returned and deliveries resumed, he would write "I've got 6 and you can send more!". Daniel and Dominic now had a DL-Service with **flow control**!

Umberto and Ursula were now very happy - they had a reliable DL-Service. They did not know how it worked, nor do they care. They knew nothing of the protocol Daniel and Dominic used. They just know about the service and they liked it.

The picture on the right shows Daniel and Dominic implementing their service.
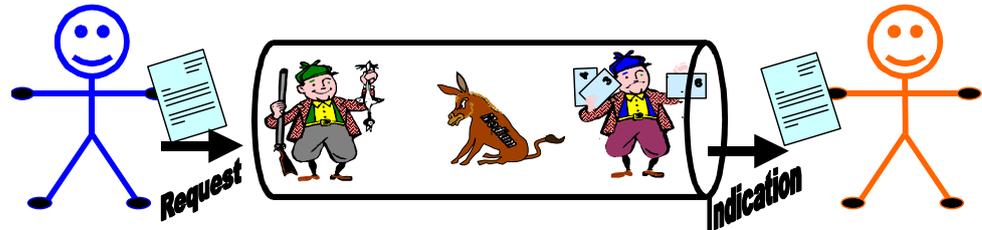
Daniel and Dominic implementing their "Reliable DL-Service".

3. A network grows
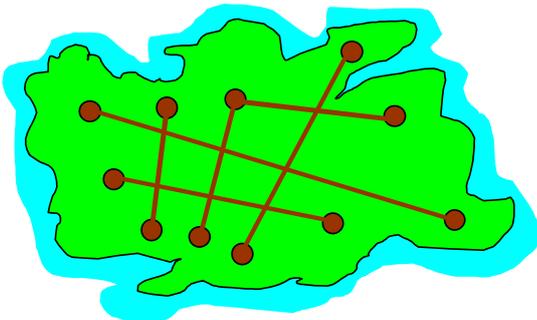
The DL-Service and its imitators (plus evidence of one cheating lover)

The Physicalians know a good idea when they see one and, pretty soon many others began to copy Daniel's idea. The island became covered with a tangle of services each connecting a pair of separated lovers.

An enterprising lady called Norma said "This is stupid! I can do it cheaper!". Norma raised some capital and opened what she called "packet-switching exchanges". She bought out Daniel and his imitators and re-employed some of them to work for her. She began to advertise what she called the "N-Service".

Norma gave all of the lovers their own addresses. She went to Umberto and said "You should use my N-Service, it does everything the DL-Service did but it is more efficient". She gave Umberto some of her own envelopes and told him "When you want to begin sending letters, send me an envelope marked "start" on which you have written Ursula's address". Umberto objected, "You said your service was the same as the DL-Service, now you tell me that I have to send strange extra messages before I can begin!" Norma said that the extra messages were actually a service
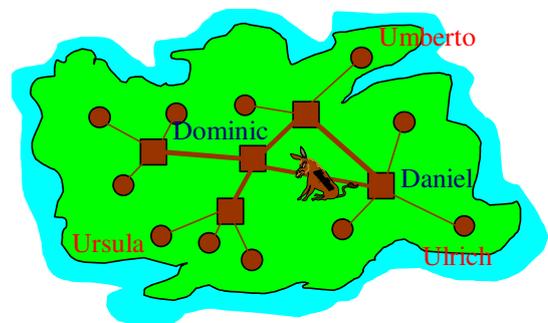
Norma's packet-switching network

enhancement. For example, there was another message called "stop" which Umberto could use if he ever wanted to stop writing to Ursula. Umberto said that he would love Ursula always so he had no need for this extra message. Norma then played her trump card, "Ah!", she said, "but you can multiplex!". Norma explained that when Umberto sent her a "start" message she would give him a number to identify the "connection" – she called this a "connection identifier". Umberto should write this connection identifier on every envelope that he sent to Ursula. Stifling Umberto's objections to this extra complexity, Norma continued, "You can give me as many 'start' envelopes as you like so you can write to several different people. I will give you a different connection identifier for each one. I will use the connection identifiers to make sure I always deliver your letters to the right people". Umberto objected once again that there was and would always be no one else in his life except Ursula. However, Norma said "What about Ursula's mother Ulrica? Think how impressed she would be to receive letters from her prospective son-in-law!". Umberto could see the strength in this. Ulrica's expressed opinions on Umberto's character and mental prowess had not always been complementary - a little oiling of the wheels could do no harm. (A thought also began to form in Umberto's mind that the "stop" message might actually have a use at some time in the future).
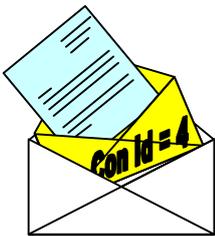
One of Norma's N-Packets inside a DL-Frame

So, Umberto began to use Norma's service as, eventually, did all the other users. Veritable herds of donkeys now plied the mountain tracks. They carried their own envelopes as before but instead of carrying letters, these now carried Norma's envelopes which she called N-Packets. Daniel, Dominic and Medium were employed between two of Norma's packet-switching exchanges, their DL-Frames always stuffed with N-Packets. They missed the friendly contact they had once enjoyed with users but appreciated the regular, steady employment generated by all the traffic between the many pairs of lovers whose letters travelled along their piece of mountain track. When Daniel and Dominic delivered N-Packets at the packet-switching exchanges, staff there would look at the connection identifiers and forward the letters on the next mountain track.

Start request
Letter requests
Stop request

Start indication
Letter indications
Stop indication
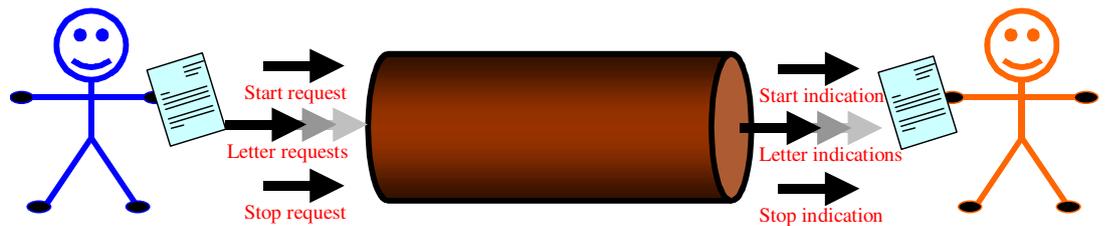
Norma's Connection Oriented Network Service. "We connect you!"

3.1 Meanwhile, on another island…

Norma's enterprise was viewed with interest by one inhabitant of the neighbouring island of Lania. This was Mick MacFramer, a Scott and a distant cousin of Daniel and Dominic. Lania was a small, mountainous island with numerous fishing villages connected by a coast road. Mick decided Lania needed a service like Norma's. However, Mick had only
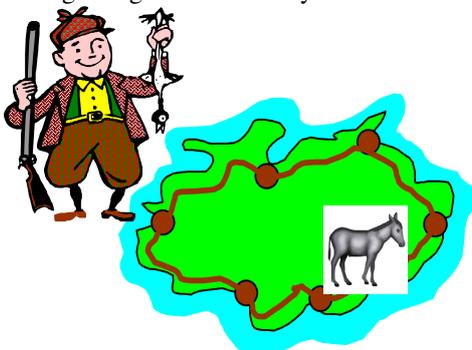
Mick MacFramer and his shared medium.

one donkey (also, coincidentally, called "Medium") and had no desire to split his anticipated profits with other donkey owners. Fortunately Mick's Medium was both highly reliable and fleet of foot. Mick devised a scheme whereby Medium would run continuously around the coastal road picking up and delivering letters from the villages he passed. Naturally the envelopes would need to be addressed so that they could be delivered to the correct inhabitant. Mick called his envelopes "MacFrames". Villagers who wanted to send letters would write an address (a "MacAddress") on a MacFrame and wait for Medium to come round. If Medium had an empty slot in his saddle-bag he would accept the MacFrame. If not, the villager would have to wait until Medium's next visit. Mick called this scheme the "MacAlgorithm". (Mick was stubborn enough to face down the many friends who pointed out that prefixing every feature with the word "Mac" made the whole scheme seem down-market and ridiculous).

Norma, Daniel and Dominic poured scorn of Mick's scheme. "Where is the reliability, where is the flow control?" they cried. Mick said, "My Medium is highly reliable and high-speed to boot. I have no need for your connections and complicated protocols. Mine is a 'Connectionless' service". "But you've only got one donkey for the whole island!" said Norma. "Yes", Mick replied "I've got a shared medium".

Though Norma continued to ridicule Mick's network, she was secretly impressed by his approach. Daniel, Dominic and their friends cost a lot to employ; were they really necessary? Norma began to plan a new version of her network without Daniel and Dominic but with more reliable donkeys. The donkeys could carry Norma's packets directly; what was the point of Daniel's frames if there was to be neither flow nor error control? For old-time's sake though, she would call her new-style packets "frames". Perhaps the network itself should be given a new name; something snappy like "Frame Relay" for example? Norma even had the wild idea of making all her frames very small and all one size. Umberto and Ursula would have to chop up their letters into suitably sized chunks in order to make them fit. She had a vague notion that this would reduce the end-to-end delay. However, whenever she mentioned this idea to anyone else, they just laughed.

3.2 Getting it all together

Now, Norma and Mick had many relatives spread across the neighbouring islands. Norma's brothers, Nigel and Neil, set up networks like Norma's on their islands. Mick's cousins, Mel and Matt, imitated Mick's network on theirs. The advent of discounted weekend boat trips between the islands meant that inter-island love affairs became common. It seemed clear there would be a healthy market for a "global" network service covering all the islands. The network operators met together. They knew that no two of their networks were quite the same; some had connections, some were connectionless, each had its own way of writing addresses. They needed to agree on a common standard but they all stuck obstinately to the view that "my way is best".


Umberto's Uncle Sam preparing a meal for his guests

The deadlock might have continued forever were it not for the intervention of Umberto's Uncle Sam who happened to run the hotel in which the network owners held their interminable meetings. Uncle Sam had a brilliant idea; **he** would build the global network! He would have his own envelopes, which he would call "datagrams", and would use the existing networks to carry them. The existing networks would not have to change at all! Fearing that customers might feel that inter-island communication would be beyond their means, Sam called his idea the "It's not too expensive really" network; or Internet for short.

Sam insisted that all his customers had to be connected to one of the existing networks. In addition to the addresses they had for these networks, Sam issued them with "Internet addresses". It was these Internet addresses that were to be written on Sam's datagram envelopes. Now Sam opened offices on each of the islands and subscribed each one to its local network. Sam's customers placed their inter-island messages in datagrams and filled in the Internet addresses of their distant lovers. They then sent them to Sam's nearest office using their local network. To do this, of course, they had to know the local network address of Sam's office. However, once they had resolved that little difficulty, the whole process was quite simple. The picture on the right shows one of Sam's datagrams being carried by Norma's network.
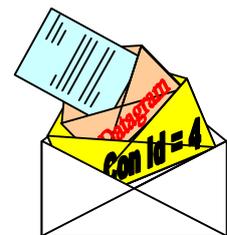
*One of Sam's datagrams inside one of Norma's N-Packets inside a DL-Frame*

Sam called his offices "routers". This was a brave decision on his part since Sam had a strange, slightly comical, mode of speech which caused him to rhyme "route" with "flout" rather than with "flute". When a datagram arrived at a router, the staff there would unpack it from its network envelope or frame and look at the Internet address, they would then decide where to send it next. In this way, datagrams would be passed from router to router all the way to the destination network. Often the journey to an adjacent router would cross one of the original networks; but, obviously, this could not be the case for the inter-island hops. This, of course, was solved by Derek the Dolphin and his friends.

Another clever idea of Sam's was to have the staff in the routers send each other messages reporting their current situation. A router with a big back-log of datagrams or with a sick dolphin could then be left in peace while datagrams were sent via a different route.

Sam's service was very simple; in fact it was a connectionless service rather like Mick's. Sam explained, "My datagrams have to be carried by all sorts of different networks. That's much easier to achieve if you keep things simple!"

The picture on the right shows a small portion of Sam's network - which was so successful it grew and grew and grew!

Now Umberto, Ursula and all the other users were **really** happy. They had a **global network service**!
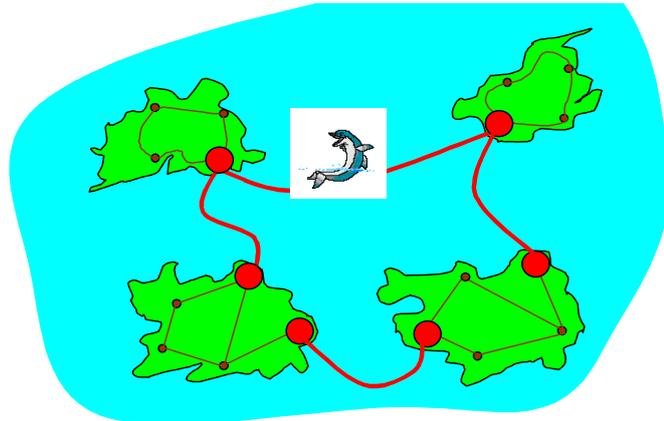
A little bit of Sam's global "It's not too expensive really" network and Derek the Dolphin

4. All's well that ends well

Sam's service was certainly global and certainly simple. Unfortunately it did sometimes discard datagrams or deliver them in the wrong order. More surprisingly, it occasionally delivered datagrams twice! One Christmas Umberto ordered a turtle dove from a company called PerfectXmas.com who promised to deliver it, gift-wrapped, to Ursula on Xmas eve. Unfortunately the Internet duplicated Umberto's order so that two turtle doves were delivered. These birds, belying their peace-loving image, fought like alley-cats and made a terrible mess of Ursula's kitchen. Umberto complained to whoever would listen that "something should be done".

An entrepreneur called Trevor heard these complaints and perceived a business opportunity. "What these users need", he said, "is a reliable end-to-end service." Like Sam, Trevor could see that there was no hope of getting all the network operators to agree on how this should be done. Instead, he would build his own service on what Sam already provided. Trevor planned a truly massive operation. He would need an office in every village in the archipelago. Users would no longer approach Sam direct, they would make a request to their local "Trevor service". Trevor's service was connection oriented like Norma's. Users first had to ask for "Trevor Connections" to be set up. They could then ask for messages to be sent along their Trevor Connections. Trevor gave very strong guarantees that all messages would be delivered once and once only and that they would be delivered in the order in which they were sent.

Trevor had to work out some quite complex rules or procedure in order to ensure he could meet the guarantees he was offering. Not being one to hide his light under a bushel he called these rules "Trevor's Completely Perfect" rules or "TCP". Naturally, Trevor had his own envelopes which he called "Trevor Protocol Data Units" or "T-PDUs". In fact these looked a bit like the ones used by Daniel and Dominic with numbers written on them so that Trevor's staff could check that all the T-PDUs had arrived and that they were delivered in the right order. Just like Daniel and Dominic, Trevor's staff had to keep copies of the messages they sent until they received acknowledgement T-PDUs from the final destination. Trevor allowed users to have several "Trevor Connections" open at the same time. This was especially useful to miscreants who were maintaining liaisons with several lovers. To help them manage their connections, Trevor allowed users to nominate several "port numbers". A cheating lover could tell one partner always write "port 23" on a T-PDU when starting a Trevor Connection another could be told to write "port 25" and so on. The recipient could look at these port numbers and quickly and unambiguously tell which partner was communicating – which avoided many potentially embarrassing mix-ups.
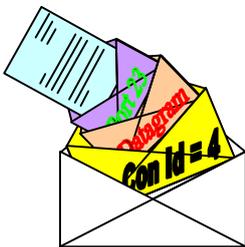
One of Trevor's PDUs getting ready for a journey to port 23.

Trevor's service was hugely successful. Soon Norma, Mick and even Sam stopped dealing directly with users. Users dealt with Trevor, Trevor dealt with Sam and so on.

Generally users were very happy with their Trevor Connections. However, you can never please everyone. Some users had found Sam's cheap, if haphazard, service suited them very well and regretted that they could no longer use it. Trevor privately thought these users were stupid but, if there was a demand and people were prepared to pay, then why should they not pay him? He started a "no frills" service which was really the same as Sam's service except for the usual extra set of envelopes. On these, users could write port numbers exactly as they did for Trevor Connections. Trevor called this new arrangement the "User Datagram Protocol".

5. Controlling Conversations

Most people were pretty happy with Trevor's two services, one or other of them seemed suitable for almost any conceivable activity. Entrepreneurs appeared offering various kinds of service based on Trevor's. There was an inter-island service sending bouquets to distant lovers ("Flower Transfer Provision") an information service for trawler operators ("Tell-Net") and one for suspicious lovers called "Who's doing What and with Whom?" ("WWW"). Users were very happy with these services which grew and grew and made Sam's Internet the most successful communications network that the islands had ever seen.

Perhaps that should be the end of our story but, for completeness, we should relate the efforts of two other groups who tried to convince the world that Trevor's service was inadequate and that more was required.

Sean and some of his backers discussing envelope design

The first group was led by Sean who noticed that all services needed to be started and stopped. Sean called the interval between starting and stopping a "session" and reckoned there might be a market for a "Session Service" with its own special envelopes on which "start" and "stop" could be written. Sean envisaged several other envelopes, for example one which said "OK, I've finished, now its your turn to send". Sean floated his idea and soon collected a large group of supporters who were prepared to invest in his idea. Unfortunately, many of these people seemed to think that the more envelopes they invented the more money they would make. There were envelopes saying "this is where we've got to", "let's go back to where we last were", "normal delivery", "special delivery" and on and on. In fact, in the end, they produced 21 different kinds of envelopes. Bravely, Sean's marketing department promoted this as a "comprehensive service". Sceptical users, happy enough with FTP, Tell-Net and the WWW, called it a "mess".

Nevertheless, Sean set up offices alongside Trevor's and tried to sell his envelopes. Whenever he did so, his staff would run them next-door to Trevor's office and ask for them to be sent to their destinations.

6. Nation shall speak unto nation

The second group was led by Peter. Peter knew that several different languages were used by the islanders and that few knew more than a smattering of any but their own language. He saw that users might pay for a service which allowed then to communicate across these language barriers. However, natural language translation is not easy to automate. Therefore, Peter insisted that users of his service should begin by setting out the structure of the messages they planned to send as a sort of form letter. For example:

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Dear <lover's name>,

     I yearn for you <"deeply", "longingly", "terribly" (delete as
appropriate)>. I think of you <"often", "constantly", "through the
long lonely nights" (delete as appropriate)> …
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This allowed translation to be a completely mechanical process. Peter invented his own *lingua franca* which he said was "basic, efficient and rapid" (BER). Peter set up offices next to Sean's. Staff in these offices would take completed form letters from users, translate them using BER and pass them on to Sean's staff for transmission. At the destination, Sean's staff would pass the messages to Peter's staff who would complete the translation into the local language.

Peter's idea was a good one but, sadly, it was not a commercial success. The problem was that successful services like the WWW already had their own translation mechanisms built in, so they had no need of Peter's service. Peter is still in business (as is Sean) but sales remain poor and the prospects do not look bright.

7. The final chapter

Ursula, Umberto, Ulrica and all the other users were now blissfully happy. Not only could they communicate reliably with each other, they could also use services like the WWW. As the Internet grew and grew more and more services began to appear and donkey husbandry became a boom industry.

With their love sealed through the use of FTP and their confidence in each other's fidelity bolstered by the WWW, Ursula and Umberto married and, of course, lived happily ever after.

The moral of the story? You cannot properly address quality of service issues when the underlying medium is a donkey.