Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com. Folks, for the first time I can tell you what day it is. So welcome to this 365 days of astronomy for October the 25th – and this is *The TDRS System.*

The TDRS or Tracking and Data Relay Satellite system is some nifty communications infrastructure that supports our presence in space. I say our, in the *for all of mankind* sense, although it's largely used by NASA to support low Earth orbiting spacecraft, including the Space Shuttle fleet and the International Space Station.

TDRS is also used to get vital science data collected by unmanned orbiting spacecraft – including all those fabulous astronomy images captured by the Hubble Space Telescope. TDRS is also by other US government agencies for other purposes, but if I passed on any details about that I might find there's knock at the door in the middle of night and…(*sir, step away from the podcast*). Just kidding.

There are currently nine TDRS satellites in geosynchronous orbit – which being at 36,000 kilometres altitude means that the space shuttles, the ISS and other satellites which are generally orbiting at a few hundred kilometres altitude actually broadcast upwards in order to get there signal back down to Earth via the TDRS system.

Normally a constellation of at least six TDRS satellites are active throughout the day, which is more than enough for fairly comprehensive global coverage – so the presence of an extra three back-up units is some indication of the importance of maintaining constant communications with spacecraft in orbit.

The last thing anyone wants is a repeat of the Gemini 8 experience where Neil Armstrong and Dave Scott, first informed Houston a docking procedure had 'gone quite well' only to come back on air a few minutes later with 'we've got serious problems here – we are tumbling end over end' – the outcome of a thruster malfunction which resulted in Armstrong aborting the remaining three days of the mission and undertaking an emergency re-entry that they were lucky to survive.

By the time of the Apollo missions, NASA had established a Manned Space Flight Network made up of ground-based tracking stations at Goldstone, California, Spain and Australia to provide more comprehensive global coverage. The Manned Space Flight Network operated alongside the Spaceflight Tracking and Data Acquisition Network – which had been established to support an increasing volume of unmanned orbiting spacecraft in the sixties.

After the end of the Skylab program in 1974, the two spaceflight networks were merged into a single Spaceflight Data Tracking Network to manage all spacecraft tracking in Earth orbit – operating alongside the Deep Space Network, which had supported the Apollo moon missions and was now devoted to tracking an increasing volume of robotic interplanetary missions (and which I hope to tell you about in another 365 days podcast, next week).

But anyway, with the advent of the Space Shuttle era in the eighties NASA set about establishing a whole new way to communicate with spacecraft in Earth orbit. The first ever TDRS satellite was launched aboard an early Space Shuttle mission STS-6 – which sent the satellite on its way via a geosynchronous transfer orbit until it was safely parked at 36,000 kilometres altitude. The second ever TDRS which was launched aboard the Challenger on the doomed STS 51-L mission never made it into space. Then a further five TDRSs were successfully launched aboard later shuttle flights and three more second generation TDRSs were launched aboard Atlas rockets in 2000 and 2002 – achieving the current complement of nine TDRS satellites.

Virtually from its commencement, the TDRS system was widely hailed as achieving more consistent communications coverage for the space shuttle missions than all the previous ground based tracking stations combined. With the steady addition of new TDRS satellites in orbit, the previous Spaceflight Data Tracking Network evolved into what is now referred to as the Space Network – although it's just as often called the TDRS system.

So, how do you place TDRS satellites to get full global coverage? Although 36,000 kilometres might sound like it's high enough to get a good coverage of the Earth with just two satellites on either side, we are talking about a planet with a 13,000 kilometre diameter and it works out you really need at least three satellites to get full line of sight coverage – and having five or six is even better in the event of high data traffic.

There are three key points on the geosynchronous orbital ring that need to be covered to make all this work. These are 41 degrees, 174 degrees and 275 degrees west – being points on the orbital ring corresponding to degrees of longitude around Earth's equator. These points are just roughly 120 degrees apart, because what we really need are points in the line of sight of strategically placed ground stations – and it's kind of difficult to establish a ground station in the middle of an ocean.

As it happens, TDRS satellites parked at 41 degrees and 174 degrees west are both in the line of sight of the White Sands complex in New Mexico, which is the main site of data relay to and from the TDRS system. The third key TDRS location at 275 degrees west used to be handled by an Australian ground based tracking station, but more recently has been managed by the Guam remote tracking station when it came on line in 1998.

The TDRS system means that a fast-moving low Earth orbiting spacecraft, either manned or unmanned, can almost continuously ping any of the active TDRS satellites above them – around their whole orbit. And this makes sense, because apart from a few geosynchronous weather satellites, if you want to study the Earth from space, you're going to get a lot more detail from a low Earth orbit of 300 kilometres than you are from a geosynchronous orbit of 36,000 kilometres.

And it's not just about studying Earth either. The Hubble Space Telescope sends data through the TDRS system about twice a day. Also, TDRS also provides communication support for the US McMurdo station in the Antarctic. In fact, mentioning McMurdo leads me to telling you about yet another communications network, the Near Earth Network which provides launch and landing support – particularly for Space Shuttle missions and also the proposed Constellation program whenever that gets going. Near Earth Network sites are in Florida, Virginia and the Antarctic (that is McMurdo) – with occasional non-US contractors brought in to provide launch support from the Arctic, Scandinavia, South America and Australia.

And it all kind of fits together. It's the Near Earth Network that supports launching or landing spacecraft beneath a ceiling of about 70 kilometres. Then the Space Network, also known as the TDRS system, takes over – providing Earth orbit support. And for any spacecraft going to the Moon or beyond, the Deep Space Network can kick in – which you'll hear more about next week.

And look I'd love to tell you how the TDRS system actually does a whole lot more than just support the Space Shuttle, the ISS and the Hubble – but (*sir, step away from the podcast*) I think I'll just leave it there.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website hoping to make 2010 the international year of the department store telescope. No ads, no profit, just good science. Bye.