

Title: SCRIPT: " FIGHTING FOR SPACE" PAGE ONE



NARRATOR (RALPH INESON)

Christmas Eve 1998 and a group of enthusiasts have arrived at a remote English lighthouse, a place of pilgrims.

They're all members of South Barry Amateur Radio club and they're paying homage to their hero Guglielmo Marconi who, exactly a hundred years before, sent a brief radio signal eight miles across the English Channel to an anchored lightship and in doing so, changed the world.

Today we're surrounded by an invisible, silent cacophony of radio waves permeating every corner of the Earth.

From national defence to taxi cabs, from television to mobile phones, radio is the invisible link that holds us together on earth, and our only way of calling across the emptiness of space.

This is the story of a century of radio. From Marconi's first ground breaking transmissions to the probes we send into the depths of space.

In 1997 a space probe was launched towards Saturn. A seven year journey through the cold, emptiness of space will be followed by a four year study of the giant planet. It's a miracle of space technology, but also a miracle of communication.

## RODNEY BUCKLAND

The Cassini Huygens spacecraft will travel over three billion kilometres to get to the Saturn system, and when it's there it will collect all the data required by twenty seven different scientific teams distributed all over the world.

## BOB MITCHELL

When we first want to gather data we have to be able to point the cameras, the instruments at the target of interest whether it be Saturn or the rings or Titan or one of the rocky moons.

So for a period in each day of about 16 to 18 hours we will point the spacecraft wherever we need it to be to observe the targets and we record that data on board.

We have two solid state recorders onboard the Cassini spacecraft and then for the remaining 6 to 8 hours of that day we will point the spacecraft toward Earth and play back all of that data that we have then recorded.

## NARRATOR

Communication technology is so much an everyday part of our lives on earth that we take it for granted, it's limitations even frustrate us. But space exploration still provokes all, an echo of the magic that radio must have seemed a hundred years ago.

## STEVE JUDD

Marconi came to England in the 1890's to further his experiments in radio and one of his experiments was from the South Foreland Lighthouse, where he was transmitting to the East Goodwin Light ship, which is about nine miles off shore behind us.

## GLYN JONES

Considering Marconi was using five kilowatts that's the power of five one bar electric fires, so you imagine five kilowatts to get across the East Goodwin light ship and we can work the world on a hundred watt, possibly Australia on a hundred watts, the power of one electric light bulb.

## STEVE JUDD

As time went by and he made the communication to France he was using it for the transmission of information and the daily telegraph were involved in the first transmission and the message was sent, three cheers for Marconi, via radio, so it really was the forefront of radio technology and making it a useable tool for everybody.

## NARRATOR

Since Marconi's magical discovery, we've evolved through the industrial age and have entered something called "the information age". But our information isn't earthbound, our radio signals leak out into space, a beacon of humanity, shining through the cosmos.

And if anyone could tune in, Marconi's original signal would mark the beginning of a barrage of radio noise spreading out in space, thousands upon thousands of signals from wireless broadcasts, television, communication links and radar defences.

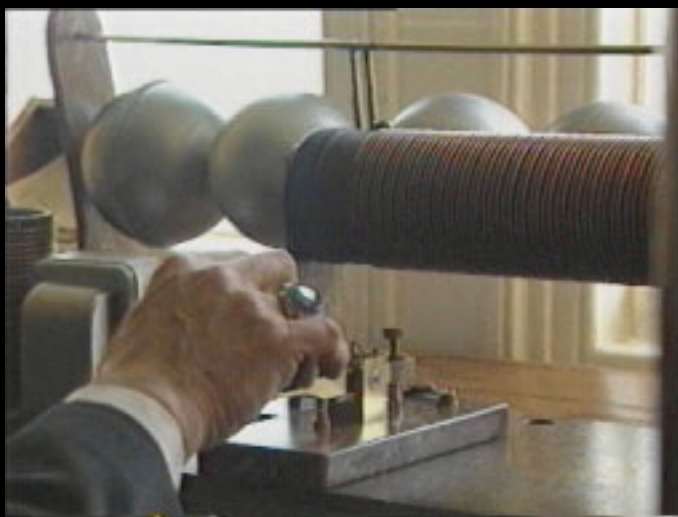
A space mission like Cassini is a remarkable display of communication technology. But it's no less an amazing example of the natural properties of radio waves.

From a transmitter with the power of a small light bulb, dishes on Earth are able to detect Cassini's call. Super cooled detectors within the Deep Space Network minimise the electrical noise that would otherwise swamp the incredibly faint signals. And when all of the data is received, earthbound communication will then be used to copy data across the globe, connecting the distant probe with universities on every continent.

Radio wasn't the beginning of the information age. A hundred years ago the communication revolution had already begun. The telephone had just been invented and the telegraph had already connected countries across the width of oceans. But radio took communication much, much further.

## RODNEY BUCKLAND

Radio was important because it provided instantaneous communications and didn't rely on many miles of copper wire strung along telegraph poles. We've been through one revolution, the telegraph but that was very inflexible earth bound infrastructure.



## NARRATOR

And radio offered something that was radically new. Unlike the telegraph or the telephone, a single transmitter could send a signal simultaneously to millions of receivers. The age of broadcasting could begin. Everyone was hooked on the wireless as the world continued to change, becoming smaller as the speed and immediacy of news led to a new age, in which communication would begin to dictate the pace of life for humans to follow.

But despite the world getting smaller, its countries weren't getting closer.

When war broke out in 1939 national leaders understood how important radio had become, a propaganda tool to focus a society.

The industrial technology of the aeroplane seemed to present an unstoppable threat to Britain. But radio offered a glimmer of hope.

Military leaders, saw in the magical, invisible waves a new weapon, a force that could be harnessed into an instant death ray.

The Government turned urgently to a young radio expert called Robert Watson Watt. He couldn't make a death ray but he did have another idea.

## ROBERT WATSON WATT

I'd watched all sorts of silly stories developing even in the official channels about stopping motor bicycle engines at a distance and killing unfortunate mice and rabbits, by some kind of mysterious radiation. But I said I don't think that in the present state of knowledge of physics that it's a very good prospect, so off hand I would say but don't believe it will help.

## NARRATOR

He couldn't make a death ray, but he did have another idea.

## ROBERT WATSON WATT

Detection by radio as distinct from destruction by radio is being examined and numerical considerations will be submitted when desired. And at that moment the civil service changed gear and came back quick saying that the considerations are indeed desired but, quickly.

## NARRATOR

Working through the night his scientific team set up a roomful of equipment and the next morning a local RAF plane was sent into the sky to pretend to be a hostile invader. The demonstration was a success and the system was developed. It was the birth of RADAR, a radical re-direction of Marconi's wireless communicator.

## ROBERT WATSON WATT

We should have been completely lost if the warning system hadn't enabled us to conserve the strength of the extraordinarily small group of twenty, twenty two year olds who really saved Britain.

## NARRATOR

Radar was vital to the war effort. Not only did it grow out of existing communication technology, it led to new ones.

Even our understanding of the universe has been radically changed by the defence miracle of world war two. From kitchen to cosmos the world would never be the same again.

The early twentieth century had seen incredible gains in astronomical knowledge as vast optical telescopes had been built to investigate the heavens.

The world's biggest telescope at Mount Wilson in California had become a shrine to science following Edwin Hubbell's discovery of millions of individual stars, grouped in galaxies far beyond our own.

But the optical astronomers had hit a limit. No-one knew how Galaxies moved or if anything lay between the stars, or even between galaxies themselves. But in 1944, in war-town Holland, a young Dutch physics student, called Henrik Van Der Hulst made a ground-breaking prediction.

He suggested that just as stars give off light, hydrogen gas, which was thought to pervade the space between the stars, might naturally be emitting a long invisible wave of 21cm, not optical light, but radio waves that could travel across the entire universe unhindered.

The potential was enormous. If the radio waves could be detected, it could open the whole universe to study, not only the stars.

This film, discovered in the archives of Leiden observatory, shows a reconstruction of the meeting at which Van Der Hulst presented his prediction to the Dutch astronomical society.

The only problem was that in 1944 there were no such thing as a radio

telescope and no one knew if the theoretical radio waves really existed.

### ADRIAN BLAAUW

For most of this was just a meeting like many others and sure we must have been told, this is very important if you could measure this, but the big if was a very very big if, especially at those moments, while you were in an occupied country, you had no idea when the war would end. You had no idea what the world would look like after this, so I do not think our thoughts went very far beyond, well this was an interesting talk, and now tomorrow we have to continue with our own problems.



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**HENRIK VAN DER HULST**

The dramatic situation was that after that colloquium it lasted exactly seven years before the first detection was made.

**NARRATOR**

When the war ended, the Dutch astronomers feverishly re-tuned an abandoned German radar dish and turned it to the skies. Beginning a race between centres of astronomy across the world to confirm Van Der Hulst's prediction.

Detection of the so called "21cm line" didn't come quickly, but by the early 1950s Van Der Hulst was a hero and radio was changing our view of the entire universe.

**BUTLER BURTON**

Already astronomy had a tremendous impact on our view of the universe, it opened an entirely new window. It revealed, for the first time, in a great deal of detail the material between the stars, the material from which stars are formed and which later when stars die, return to the interstellar medium.

## NARRATOR

Since then radio astronomy has been the single most important tool for unveiling the secrets of deepest space. The technological optimism of the post war years heightened the desire to communicate over greater and greater distance, until the earth seemed almost too small to contain it.

The moon walk seemed the pinnacle of technological achievement. But it was also a huge communications event seen live by 723 million people across the world.

## BUZZ ALDRIN

While Apollo was on the surface just that wild thought went through my mind how ironic it is that Neil and I are on the surface and we're further away from earth and everyone else than any two people have ever been and yet we're talking to them right now and we know that they are very aware through communications as to what we're doing right at this very moment.

## NARRATOR

Even the astronauts could chat back home from a quarter of a million miles away. The moon landing was a culmination of a space race but it was also pointing towards a new communications future.

## ARCHIVE FOOTAGE



## BUZZ ALDRIN

It's a sense that is combined of course with the knowledge that you're in very close contact and you're very secure because of communications and if you were to lose communications now this would drastically alter the situation because now without any contact at all you see how far away the earth is and psychologically that's going to have a significant impact on any individual.

## NARRATOR

The telephone call between President Nixon and the American astronauts looked conventional, but in a very primitive way, it used technology we would come to know as digital.

The new electronics was making it all possible and transistors and later silicon chips enabled information to be processed easily and cheaply as a series of ones and zeros.

Travelling beyond the moon presented insurmountable problems for astronauts, but new communication technology was about to render human space travellers obsolete and open up the secrets of our outer solar system for the first time.

The new digital technology made radio signals better at dealing with noise and interference. So they could travel further.

The distance from earth was increasing, but communication could still be maintained. And some scientists were even imagining the possibility of encountering aliens.

## ARCHIVE FOOTAGE

### CARL SAGAN

We think that the information on where we are and when we are indicated in this part of the message by the configuration of certain cosmic objects called pulsars, will be completely obvious to any society capable of travelling between the stars. These two objects will be more mysterious because it is unlikely that there will be human beings anywhere else, even though there may be other creatures elsewhere and the plague has served a very useful purpose in making us think about what sort of impression we might wish to give to the cosmos.

## NARRATOR

Magnificent images of the solar system were sent back from the Voyager probes launched from Earth in 1976 and 77.

But pictures of Jupiter, like this these, could not be photographic. There was no way film could be sent back to Earth.

So images were recorded digitally as a sequence of elements called pixels to be returned to earth as a radio signal.

On earth the data was demodulated and assembled back into pictures for interpretation, information liberated from data. Even transmission errors could be corrected by using special methods of coding the sigma.

## BOB MITCHELL

Typically in the course of transmitting this string of these billions ones and zeros that come down, every once in a while there's a glitch and you lose one, it will get converted, or be flipped to the other value or just noise and not recognisable. And the coding that has been put on the data when it left the space craft is such that up to some point we can reconstruct that and get the data back error free.

## NARRATOR

Similar codes will be used for Cassini when it finally reaches its destination in 2004, but twenty years after Voyager, the technology on board the new probe is far more sophisticated.

Scientists are even using radio communication to send new software to the probe's onboard computers so that it will operate just the way they want it to at the time, not necessarily the way the scientists of 1997 might have imagined, a special one hour delivery, straight from Earth.

In the twenty years between Voyager and Cassini the digital revolution that has dominated space communications has also dramatically changed the way we talk on Earth and space technology has launched satellites to shuttle data between continents. But very soon humanity is about to take another leap into the unknown.

The information age is about to make space its new information super-highway, and Bill Gates, icon of the digital age, is after some of the action with a stake in a communications company Teledesic.

## RUSS DAGGART

Telecommunication is going through a radical transformation right now. Most of the world now doesn't have access even to basic phone service. But even those places that have phone service, get it through essentially a hundred year old technology.

Analogue twisted pair, copper wires. Those networks weren't designed for the kinds of digital data communications that are becoming the norm now.

Well we're proposing to put up two hundred and eighty eight satellites, and that's required for full coverage of the earth. As soon as you come out of the Geo. Stationary orbit, by definition the satellites move in relationship to the earth. So to provide continuous coverage of London, you have to provide continuous coverage, really of the entire planet, and that requires a large number of satellites.

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**NARRATOR**

Out in space, satellites will (it's claimed) provide bandwidth on demand, an internet in the sky, speeding any amount of data instantly around the globe.

**RUSS DAGGART**

Today most people connect their computer through a twenty point eight kilobyte per second modem.

With Teledesic we're talking about speeds up to two thousand times that data rate. So, a communication that might take you hours with your current telecommunications connection would take mere seconds. And as the data volumes increase, the need for a high speed connection is also going to increase.

**NARRATOR**

Small low angle, high elevation dishes will connect users directly to satellites by radio while lasers will shuttle data between the satellites themselves.

## RUSS DAGGART

Data communications are increasing right now, data over the Internet is increasing at an annual rate of about a thousand percent a year.

Voice communications are increasing at about eight percent a year. At that rate the data communications will be about ninety nine percent of the traffic moving across the networks by two thousand and four.

There's a limit to how much voice traffic can be generated, that's limited by the number of people and how much they can talk. There's virtually no limit to the number of data bytes that the computers of the world can crank out

## NARRATOR

But this avalanche of data might be on the verge of turning a communication dream into a scientific nightmare. A hundred years of harmony could be shattered as corporations and scientists come into conflict, with radio waves at the centre of a battle for space, all because of our insatiable appetite to communicate.

## CARTOON

November first, engineers switch on sixty six new communication satellites.

## JANE LITTLEWOOD

As we all know internet in the sky, and there's going to be satellite internet and satellite mobile phones very soon available to us. And as soon as our delegates have got usage of those on a daily basis then we will have them in the centres to make sure they've got access as soon they need it.

## NARRATOR

Conference centres are the modern temples of communication. Cranage Hall in Cheshire, once a Lunatic asylum, is now home to thousands of visiting executives who come to talk.

The problem is their nearest neighbour - the Lovell telescope at Jodrell Bank.

## IAN MORISON

These new satellite based communications systems, the Iridium system has just come on-line, there are other ones, Global Star and of course Bill Gates internet system, are a really a major threat I think to us.

The trouble is that any radio transmitter broadcast beyond the nominal band its allocated, there's no way you can stop that happening the power levels are very low, but we have very very sensitive telescopes so if there's a satellite up in the sky in roughly the direction we're looking, broadcasting near the frequencies that we are allowed to use, then it will affect us.

## CARTOON

Allowing phone users from Antarctica to Alaska to confer.  
High Baz, I'm on an icecap.  
So am I.



## JANE LITTLEWOOD

More and more people need contact with their offices, people get busier and busier in their lives. Everybody is using e-mail and communication that they don't need to be face to face with, and they still need that access when they're in this centre. Although the most important part is that they're face to face, but it's good they still have communications and the access to their every day communication, such as the telephones the e-mail and the internet.

## CARTOON

However up at Jodrell Bank,  
Fools they're using our wavelengths, sixty years of radio astronomy down the toilet.

### IAN MORISON

So it just means that there are more satellites in the sky all transmitting and it just means that basically the RF noise background's going up, just in the way that the light background the, all the light from the sodium street lamps is now reflecting back from particles in the sky making optical astronomy so much more difficult.

So I'm afraid the light pollution that they've had to suffer for for many years is beginning to affect radio astronomy.

### CARTOON

Our window on the universe is misting over.

Now we may never know if there's anyone out there.

### JANE LITTLEWOOD

I don't think as a company we will be able to ever say that we will ban, outright, the use of mobile phones. We encourage people to come in and use the conference centre as they want to use it, so it would cause problems to ban mobile phone use outright.

### NARRATOR

And that could mean we miss out on an answer to one of the oldest questions humanity has asked. "Is there anybody out there?"

### CARTOON

Elsewhere in the space/time continuum,

What are you getting Zog?

It's an intelligent radio signal, sir, .. it says

$E=MC$  squared... we are carbon based bipeds living on the 3rd planet of a main sequence star so hello and welcome to gardener's question time....

Fantastic! We must draft a reply.

### NARRATOR

Ever since the discovery of radio astronomy in the 1950's, the search has been on for a radio signal from space, not the natural emissions that the astronomers study, but a message from an alien civilisation, an extra terrestrial life form.

## FRANK DRAKE

Our civilisation took a giant step in the mid nineteen fifties. We didn't realise it at the time but at that time, radio astronomy was a booming science all over the world. We were building, much larger radio telescopes than had ever existed. And at the same time new forms of radio receivers were invented, radio receivers much more sensitive than anything we'd had before. It turned out that the combination of those receivers with those much larger radio telescopes gave us for the first time the ability to detect reasonable radio signals, and by reasonable I mean signals no stronger than we were then transmitting across the distances that separate the stars.

## NARRATOR

Ever since Frank Drake's first searches radio dishes have been scanning the skies for an elusive, perhaps non-existent, signal that would tell us we were not alone.

## JILL TARTER

SETI, which stands for the Search for Extra Terrestrial Intelligence is really a misnomer. All we can do is try and find evidence of an extra terrestrial technology.

And over many years, we've debated what we should be looking for. And the idea of looking for radio signals, generated by another technology either as a beacon to attract our attention, or for their own purposes. For information transfer or for navigation, radar's to warn them of incoming asteroids, something like that. Radio signals might in fact be a very detectable evidence of a distant technology. So that's what we look for.

## NARRATOR

Today the Lovell telescope at Jodrell Bank is part of the search, linked to another radio telescope in Puerto Rico. The detectors are so sensitive, and domestic radio pollution so intense, that any signal could only be confirmed as an alien message if both telescopes made the detection at exactly the right time.

## IAN MORISON

This is the SETI equipment that we're using here at Jodrell Bank to confirm any possible signals detected by our receiver.

On the spectrum analyser here we can actually see the band of frequencies we're analysing but the real work is done in the follow up detectors, they're down here, very powerful special purpose processors that home in on the particular frequencies where the Ariscebo telescope has detected signals.

We basically try and confirm whether they're real or not.

## NARRATOR

A signal from a space probe like Cassini's is faint enough, but an intelligent signal from the stars, so many billions of miles away is on the edge of human powers of detection and the more we chat on earth the harder it gets to hear in space.

## IAN MORISON

If someone was trying to transmit to us in the bands that are currently being used and will be used in the new future by these satellite systems I'm afraid that's it we just won't, we'll never know.

## CARTOON

Twenty nine years into the future ...

Hello,

Hi, you don't know me but I'm calling from the planet 492 in the constellation of

.....

Hello? Hmm, battery's gone, Oh well probably some crank



## PRODUCTION TEAM