The Ever-Shrinking HF SITE

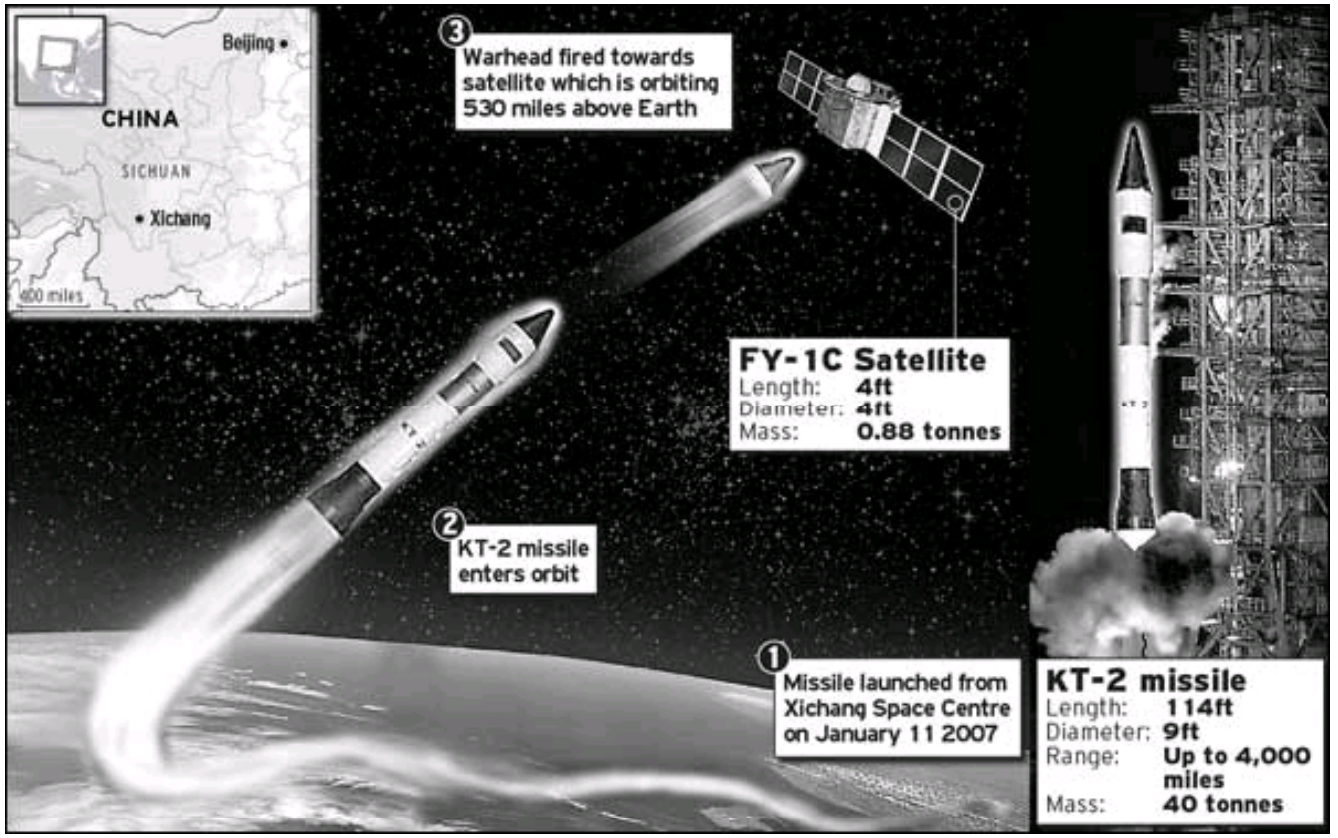
Gordon Sinclair, TCI

SPX Corporation

New Uses for HF – Adding to its Capabilities

- HF has traditionally been used for communications by traditional methods: CW, SSB, FSK
- HF Communicators are continuing to improve performance to support sending E-mail and other data using Internet Protocol (IP) at respectable bit rates
  - USAF: HF Global Communications Systems (HFGCS)
  - NATO: HFIP Program, BRASS, SSSB

Why is HF still important?



11 Jan 2007 – China destroys one its own satellites using a kinetic-energy weapon.

HF is needed as a backup when SATCOM systems fail.

Another Reason… The Internet is Vulnerable

30 January 2008 news item from BBC

“Web disrupted 'across Mid-East'

Internet services have been disrupted in parts of the Middle East following damage to an undersea cable in the Mediterranean, according to reports.

There was disruption to 70% of the nationwide network in Egypt, a government official told Reuters.

There was also disruption in the United Arab Emirates (UAE), Kuwait and Saudi Arabia, reported the Associated Press.

India also suffered up to 60% disruption, a national industry body told Reuters news agency.

The Internet Service Providers' Association of India blamed a breakdown in an international undersea cable network.

One Indian internet service provider, Videsh Sanchar Nigam Ltd (VSNL), linked the problem to the Egyptian disruption.”

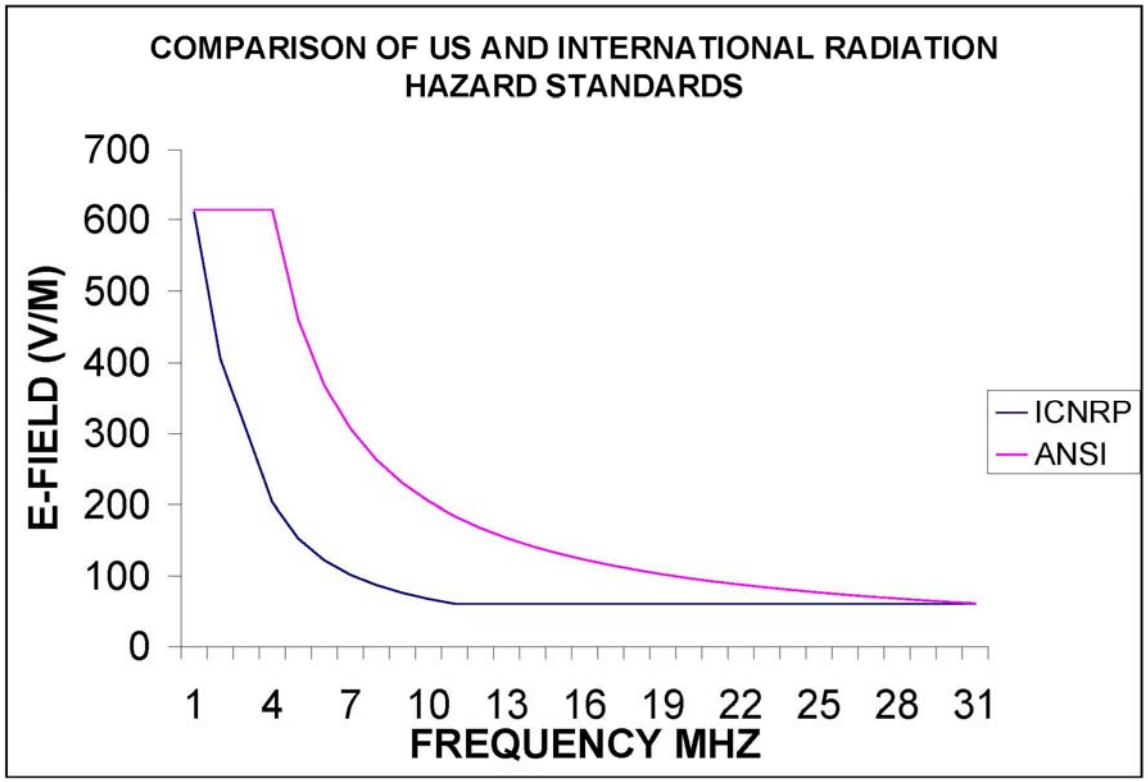
Constraints on Site Size and Usage

- Availability of land
  - Many HF comms sites were built in areas that were once remote but are now highly populated, making real estate more valuable
  - Expansion of site can be extremely expensive
  - Land may more desirable for housing, offices, shopping centers
- New Radiation Hazard Limits
  - Current RF Radhaz limits are stricter than old limits
  - Field levels at site boundaries may exceed allowables
  - See following slides for more details
- Smaller sites means antennas are closer together
  - Causes more coupling
- New Environmental issues
  - Zoning – encroachment by population that covets the land
  - Wetlands – applicable for many coastal sites
  - Protected species
- Budget constraints
  - Never enough money to do what is needed

RF Radiation Hazards

- Applicable RF Radhaz Standards
  - US Standard: ANSI/IEEE C95.1-1999
  - International Non-Ionizing Radiation Committee (ICNIRP) Guideliness - 1998
    - Applicable in most of world
    - Lower allowable values than ANSI C95.1-1999
- Radiation Hazard used to be a problem only for Broadcasters who use high powers.
- Now ICNIRP's lower allowables makes it an issue for communicators too.

Comparison Between US and Int'l Standards



Example: At 10 MHz, ICNIRP Allowable is 34% of ANSI Value
(ICNIRP 28 V/m vs. ANSI 82 V/m)

Problems When Adding More Antennas

- Interaction between antennas may require larger distance between antennas, increasing space requirements
  - If coupling between antennas is too high adjacent antennas will receive energy that will flow back to transmitters
  - Consequences of too much coupling are
    - Intermodulation
    - Excessive reflected power that may cause VSWR trips
- Combined signals radiate more energy creates increasing radiation hazard zone
  - Radhaz rules may require larger set-back of antennas
- New operational requirements may require different types of antennas for different circuits

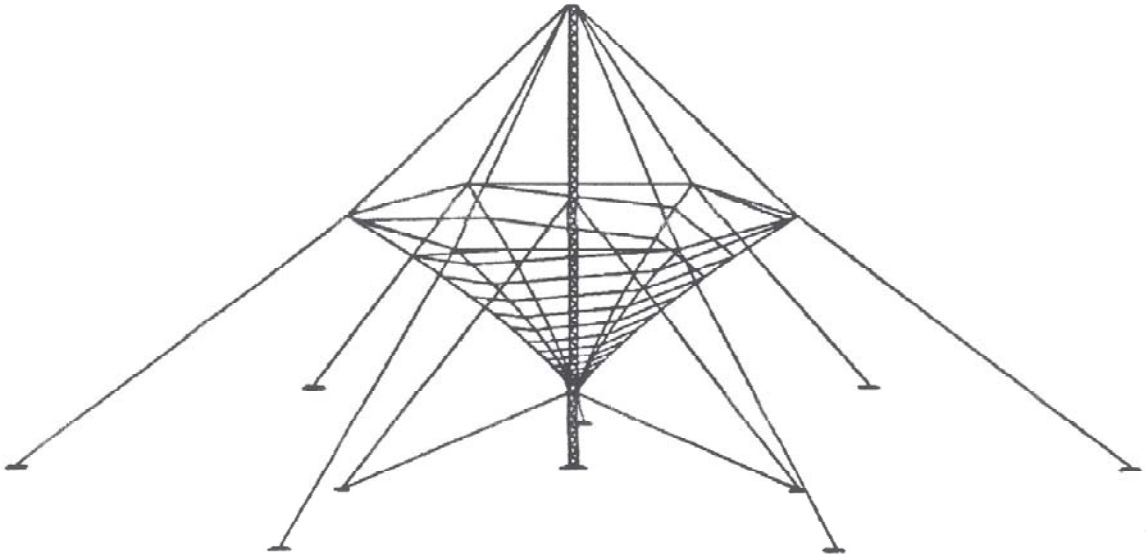
Solutions to the Shrinking Site Problem

- Use an increased quantity of smaller antennas
- Use antennas that provide more than one circuit simultaneously
- Combine antennas with different functions in the same space

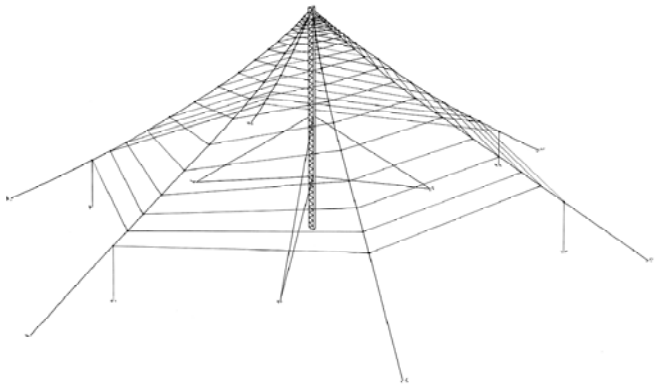
Example of Smaller Antenna

Large vs. Compact Spiral Multi-Mode Antennas

220ft



100ft



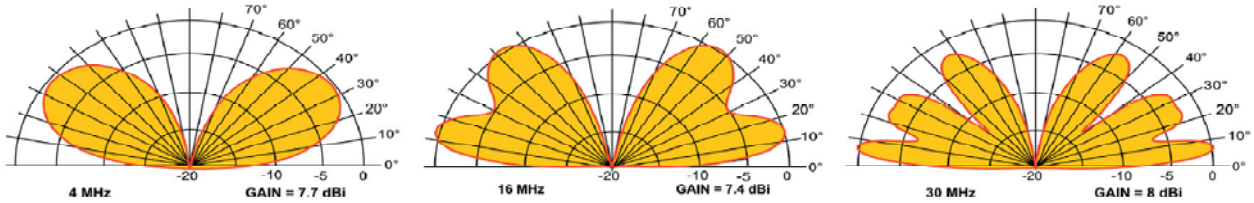
- Full Size, ~100% Efficient
- Environmental Impact: High
- Rad Haz: High

- Half Size, <<100% efficient
- Environmental Impact: Lower
- Rad Haz: Similar

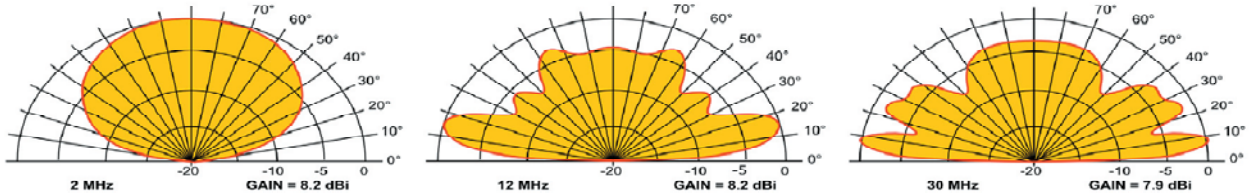
Dual- and Triple-Mode Antennas

- 2 or 3 simultaneous transmissions without frequency limitations
- Modes provide both short and long range service
  - Low angle for long range circuits
  - High angle for short range and NVIS
- Equivalent to 2 or 3 antennas in the space of one antenna

Low Angle



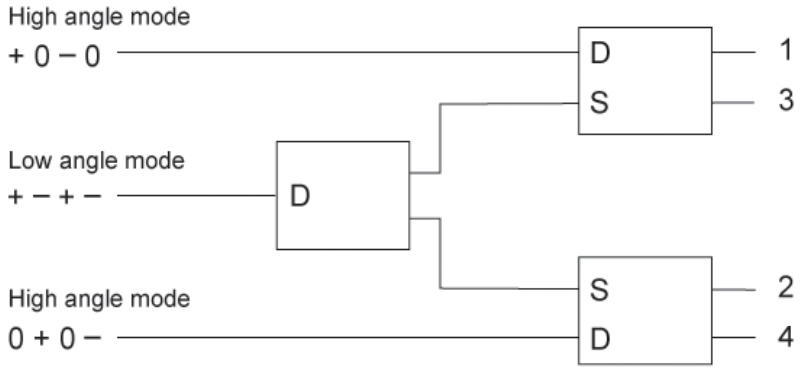
High Angle



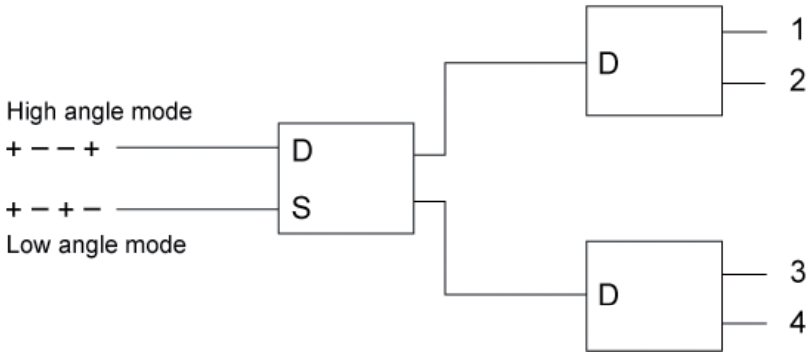
Characteristics of Multi-Mode Combiners

- Multimode combiners permit simultaneous transmission of 2 or 3 signals with no limitation on frequencies
- 2-Mode combiner
  - Can accept up to 10 kW power into each input
  - One low-angle mode and one high-angle mode
- 3-Mode combiner
  - Can accept up to 5 kW power into each input
  - One low-angle mode and two high-angle modes

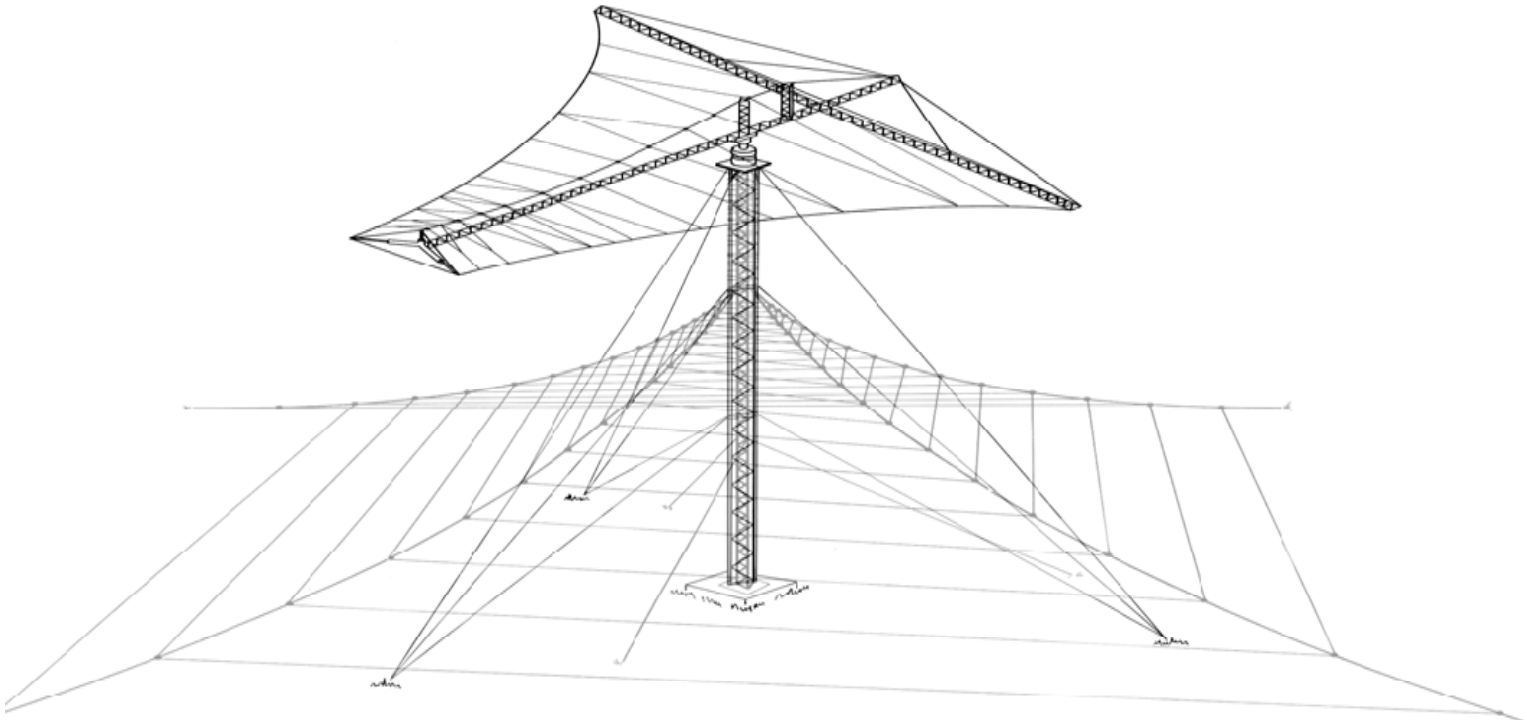
Triple Mode Combiner



Dual Mode Combiner



Combining Different Types of Antennas

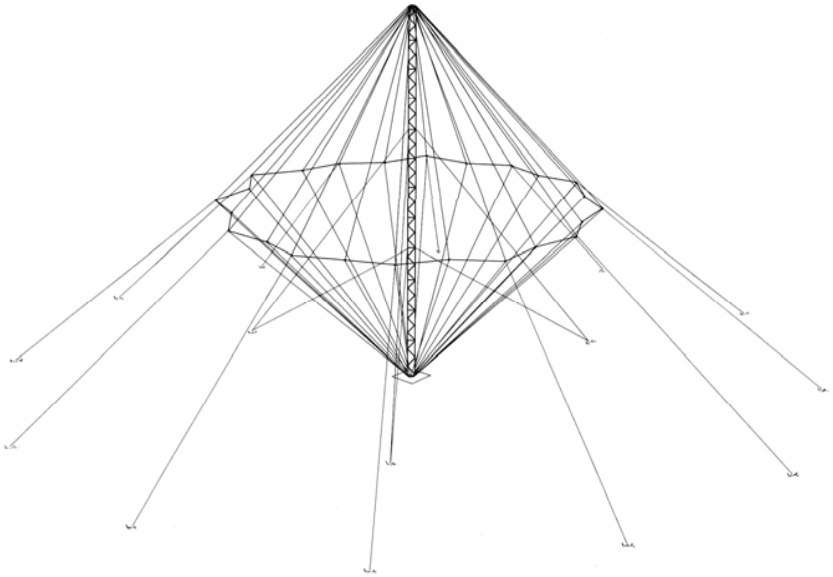


Multi-Mode Antenna Combined with Rotatable Log-Periodic

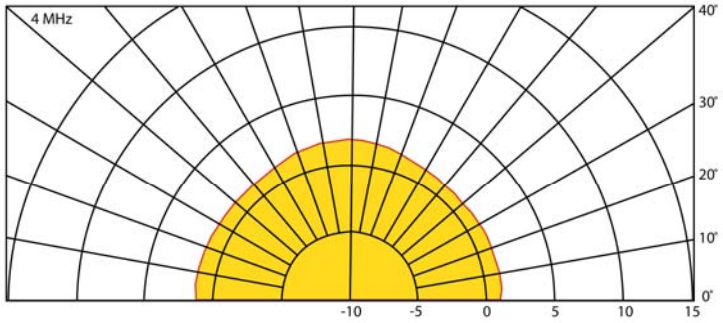
Up to 3 modes on spiral antenna

1 mode on RLPA

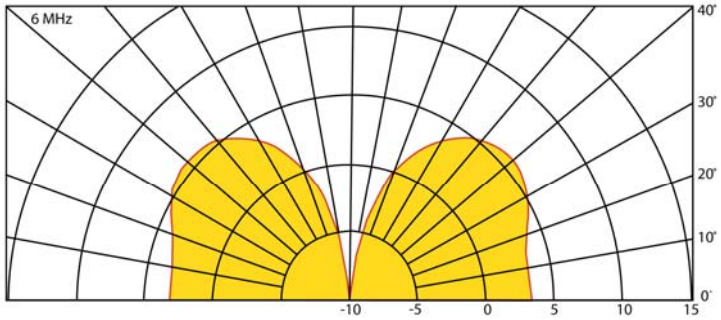
Dual-Mode Vertically Polarized Antenna



- Patent Pending
- Low angle mode for ship-shore at LOS
- Low angle mode for long circuits
- NVIS Mode for short to mid range circuits

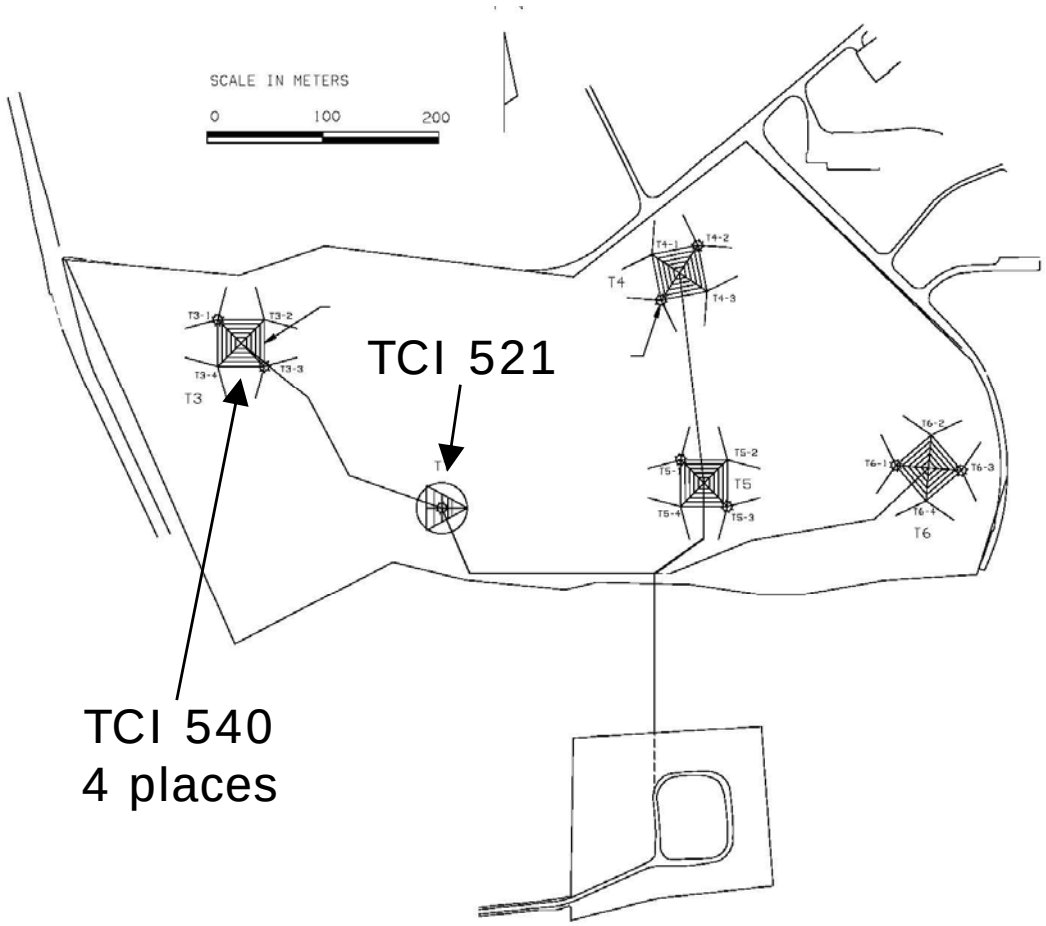


High Angle Mode for NVIS



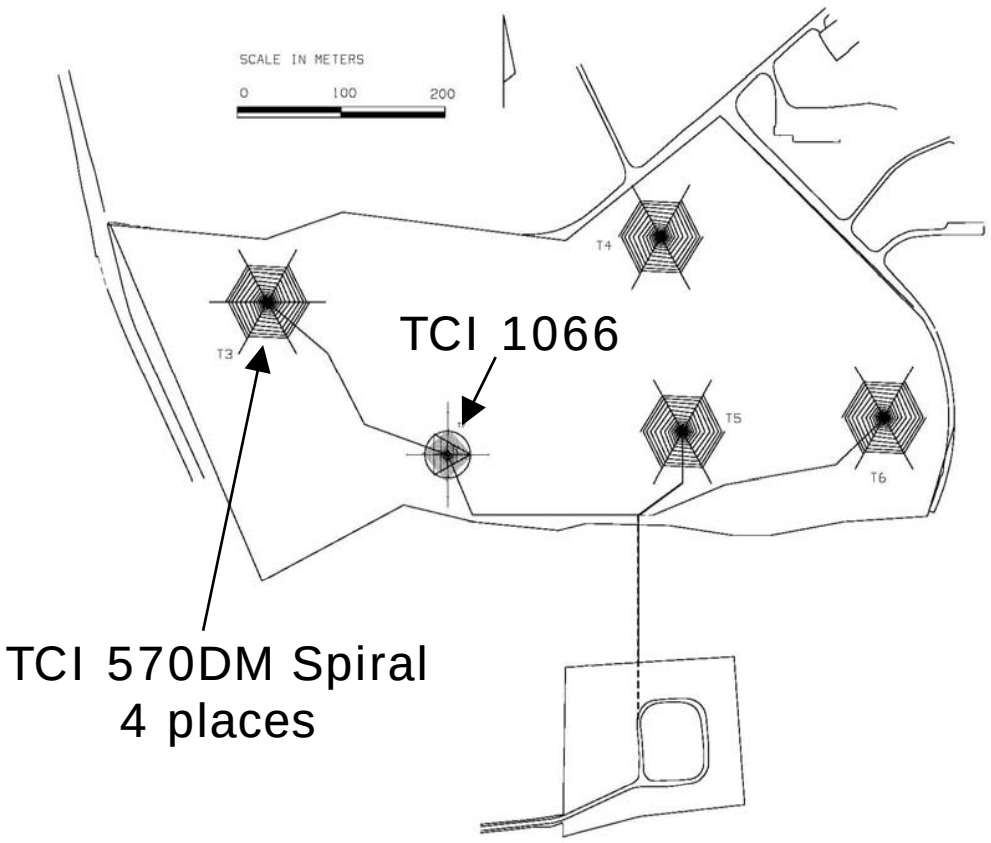
Low Angle Mode for Ground Wave or Long Range Skywave

Adding Capacity to Site – An Example



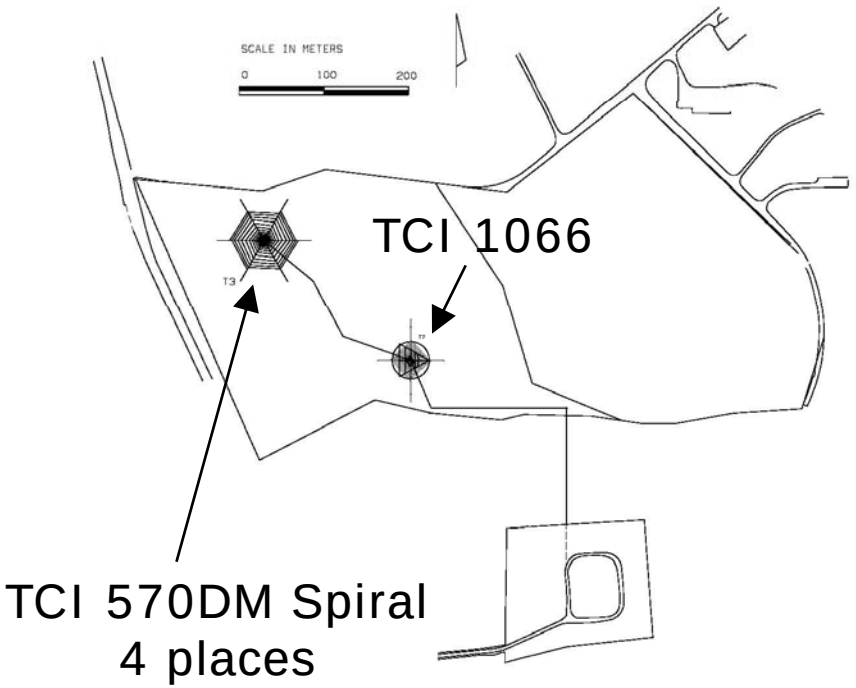
- Existing classified site
- 4 x TCI 540 horizontal omnis
- 1 x TCI 521 rotatable log-periodic
- Capacity for 5 x 10kW transmitters
- 30-35 dB isolation between antennas
- Meets stringent local RF radhaz requirements, including those for Electro-Explosive Devices (EED's)

Change Antennas – Incr. Capacity to 140%



- Replace 4 x TCI 540's with 4 x TCI 570 Dual Mode Spiral Antennas
- Replace RLPA with TCI 1066 Multi-Mode Antenna, consisting of 3-mode spiral and 1-mode RLPA – adds 4 modes
- Capacity for 12 x 10kW transmitters or 16 x 5kW
- Typical isolation 30-35 dB between antennas
- Meets same RF radhaz requirements as original site
- Occupies same land area
- Operate 12 (16)circuits instead of 5

How to live with limited space



- Replace 1 x TCI 540 with 1 x TCI 570 Dual Mode
- Replace RLPA with TCI 1066 Multi-Mode Antenna consisting of 3-mode spiral and 1-mode RLPA – adds 4 modes
- Capacity for 6 x 10kW transmitters or 7 x 5kW
- Typical isolation 30-35 dB between antennas
- Meets same RF radhaz requirements as original site
- Occupies less than half land area
- Operate 6 (7)circuits instead of 5

Summary

- Space is becoming more limited
- Expansion of circuit capabilities may be required
- Even maintaining the existing capacity seems challenging
- Solutions:
  - More efficient use of space can be achieved using multi-mode, compact antennas.
  - The same or more circuit capacity can be achieved
- Downside:
  - Lower efficiency, but with modern data transmission, connectivity should still be achievable