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Information Warfare and Evolution

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A Question:

How general is the model of Information Warfare which we can describe using Shannon and hypergame theory? Can instances fitting these models be found outside the domain of human endeavour?





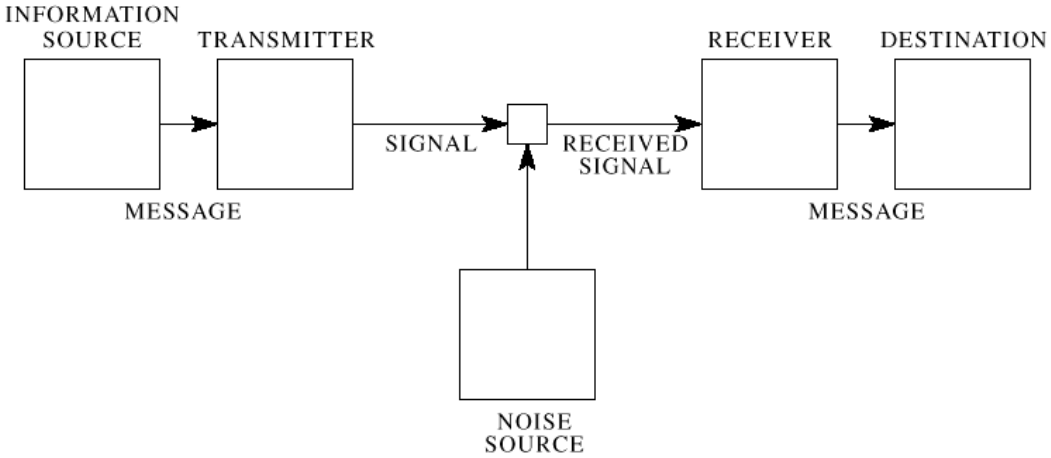


Defining Information Warfare

US DoD: *'Information Warfare is any action to Deny, Exploit, Corrupt or Destroy the enemy's information and its functions; protecting ourselves against those actions and exploiting our own military information functions'.*

- IW is defined as 'actions' which yield intended outcomes of 'denial', 'exploitation', 'corruption' and 'destruction' of an opponent's 'information'.
- The model does not provide a quantifiable basis or measure of 'information'.
- Borden (1999) and Kopp (2000) argue that Shannon (1948) provides a model to address this limitation. Shannon's 'channel capacity' model relates useful channel capacity to bandwidth and the ratio of available signal to noise.

Shannon's Model (1)



$$C = B.log_2(\frac{S}{N}) \quad (1)$$

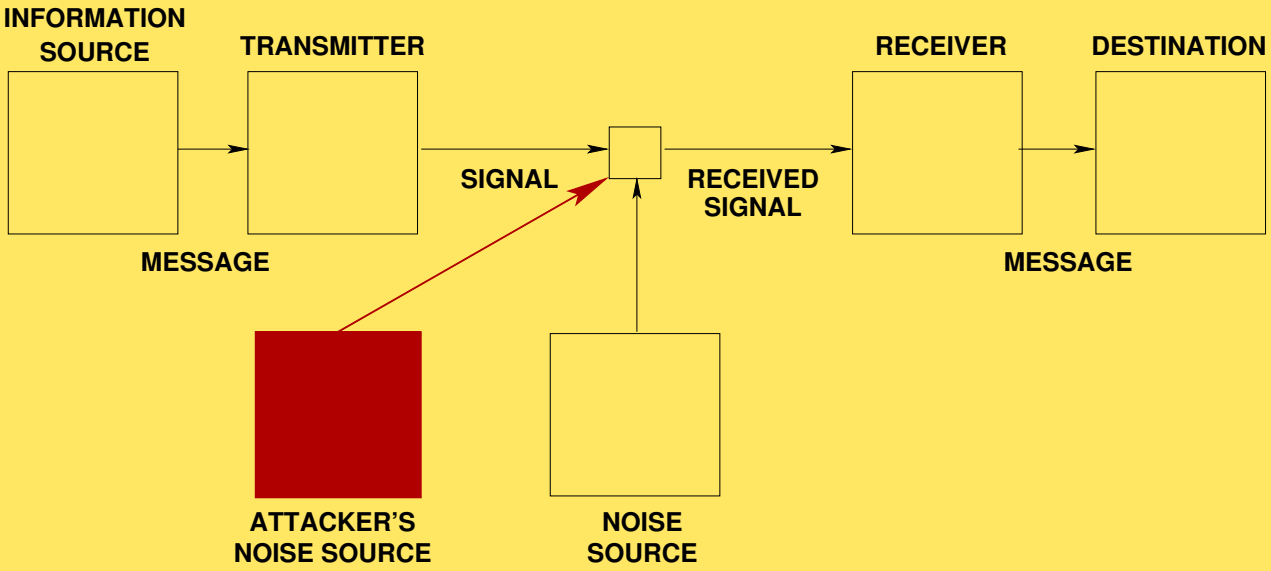
Shannon's Model (2)

- Shannon's model defined in terms of a communication channel, with a 'source', 'destination', 'transmitter', 'receiver' and a 'noise source' which impairs the channel 'capacity', otherwise bounded by 'bandwidth' and 'signal'.
- Borden: 'IW is a battle for bandwidth (capacity)'.
- Shannon's model can be easily mapped on to the four 'canonical offensive Information Warfare strategies'.
  1. **Denial of Information.**
  2. **Deception and Mimicry (D&M).**
  3. **Disruption and Destruction.**
  4. **SUBversion.**

Four Canonical IW Strategies

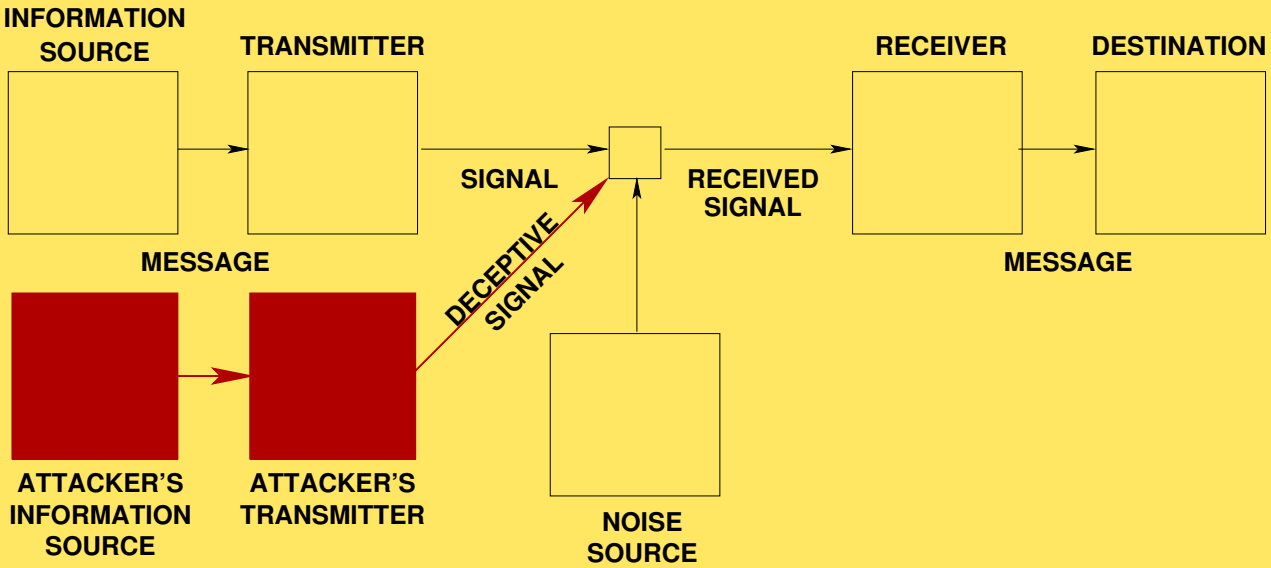
1. **Denial of Information / Degradation or Destruction (US DoD)**, i.e. concealment and camouflage, or stealth.
2. **Deception and Mimicry (D&M) / Corruption (US DoD)**, i.e. the insertion of intentionally misleading information.
3. **Disruption and Destruction / Denial [1] (US DoD)**, i.e. the insertion of information which produces a dysfunction inside the opponent's system; alternately the outright destruction of the receiver subsystem.
4. **SUBversion / Denial [2] (US DoD)**, i.e. insertion of information which triggers a self destructive process in the opponent's target system; SUB at the simplest level amounts to the diversion of the thread of execution within a Turing machine.

Model for DoI/Degradation Strategy



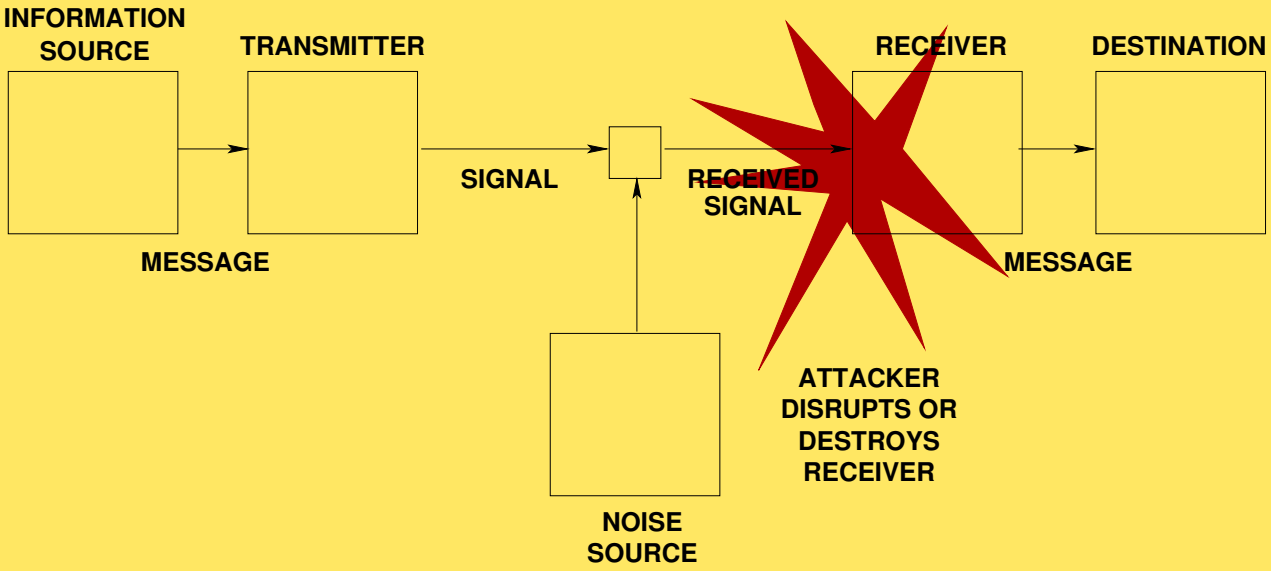
1. DoI/Degradation Strategy

Model for D&M/Corruption Strategy



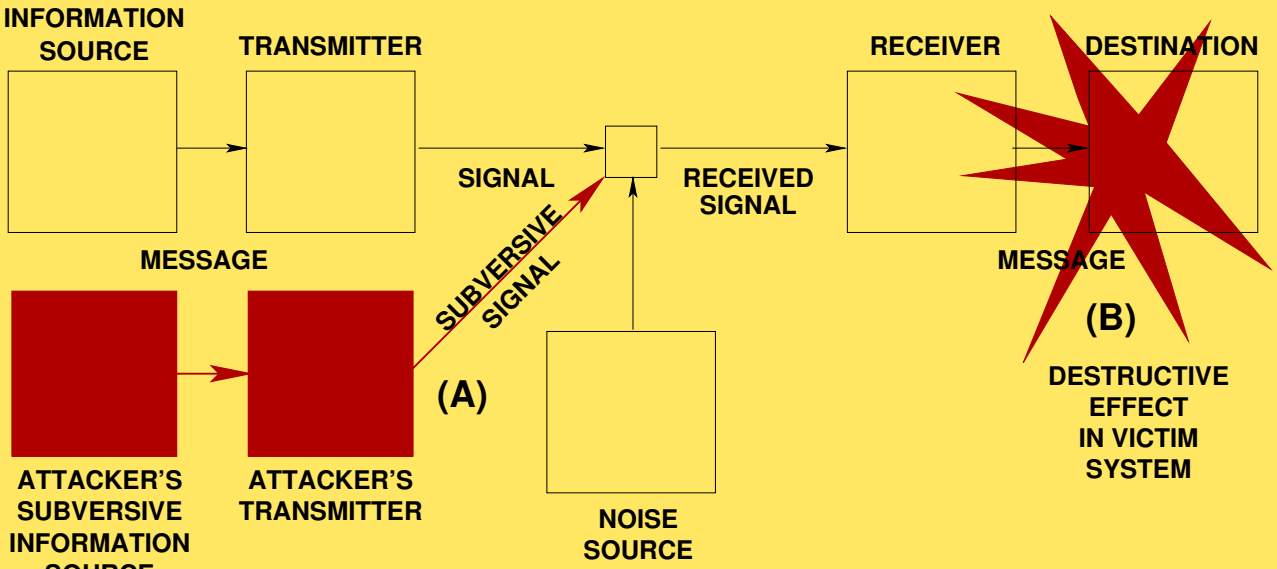
2. D&M/Corruption Strategy

Model for D&D/Denial (1) Strategy



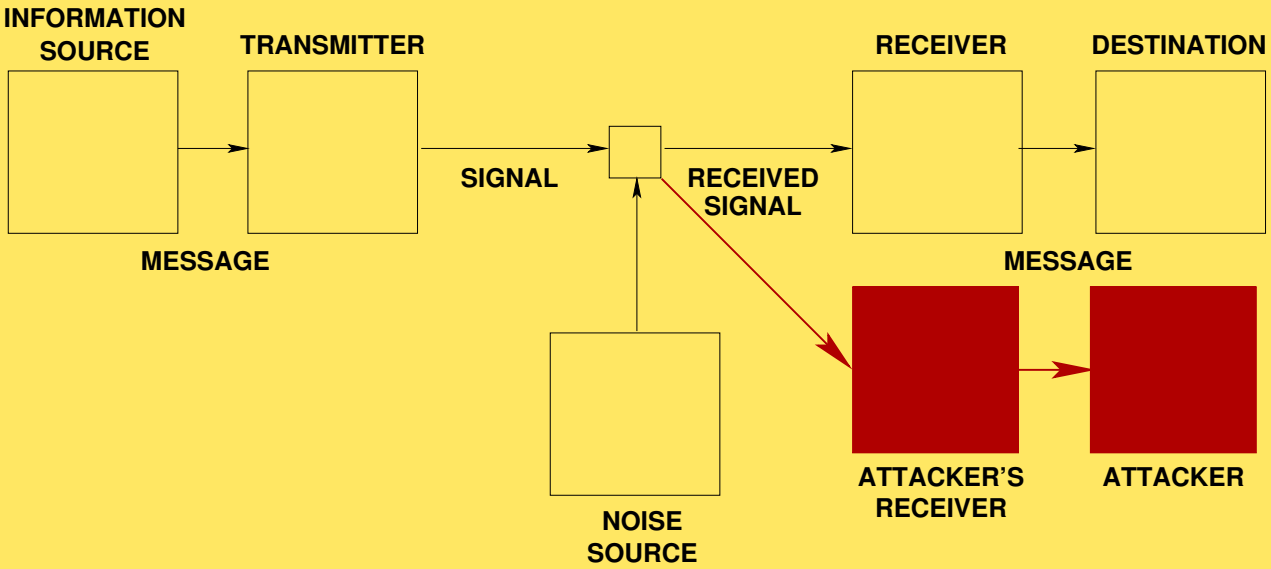
3. D&D/Denial [1] Strategy

Model for SUB/Denial (2) Strategy



4. SUB/Denial [2] Strategy

Model for Exploitation Technique



Exploitation Technique

Information Warfare in Nature (1)

- Evolutionary theorists: specific features in a species which improve its probability of individual survival and reproduction will be propagated, at the expense of features which impair the probability of individual survival and reproduction[1]. Genomes of species encode a record of the environments these species survived in.
- Biological entities need resources to survive, minimising expenditure of energy, time and material is an important optimisation.
- Food and mates are found using sensors, and threatening predators are detected using sensors. Therefore manipulation of sensor channels is a highly productive means of improving survival odds.
- *Manipulation of any sensor channel to change the outcome of an engagement is Information Warfare.*

[1] Refer (Dawkins, 1996) and (Wills, 1989).

Information Warfare in Nature (2)

Hypothesis:

Information Warfare is an evolved survival mechanism in nature.

How do we best demonstrate that this hypothesis holds?

We need to find a set of examples which meet the following basic criteria ...

Information Warfare in Nature (3)

1. The species employs one or more than one of the four canonical strategies to aid in its survival.
2. Multiple species which are not closely related, and preferably exist in diverse environments, employ the same subset of the four canonical strategies to aid in their survival.
3. Closely related species exist to the examples found, which do not employ any of the four canonical strategies to aid in their survival.

A set of species which share the common attribute of using a set of the four canonical IW strategies, yet are not closely related, could only have developed the use of this set of strategies under evolutionary survival pressure, as the absence of a near common ancestor denies the immediate inheritance of the trait.

Examples of DoI/Degradation Strategy

Most commonly found in nature, and is used both by predators and prey alike, in the form of camouflage. Camouflage yields no information whatsoever to an opponent in an engagement.

Orthoptera - Grasshoppers, Crickets and Katydids: this order is large with ≈20,000 species cited.

Mantodea - Mantids: these predators lack agility and hunt primarily by ambush, therefore the effectiveness of their camouflage will reflect directly in how many meals they have.

Phasmatodea - Stick and Leaf Insects: these slow moving herbivores have evolved camouflage in their shape, colour, texture and movement.

Camouflage (DoI) - Mantid

(Deroplatys Dessicata, ©www.bugsincyberspace.com)

Camouflage (DoI) - Phasmid

(Phyllium Bioculatum, ©www.bugsincyberspace.com)

Camouflage (DoI) - Phasmid

(Aretaon Asperrimus, ©www.bugsincyberspace.com)

Examples of D&M/Corruption Strategy

A species evolves the appearance of another to aid its survival. Not as common as camouflage but often more effective.

Lissocarta vespiformis: this Peruvian leaf hopper bug mimics the *Polybia catillifex* wasp.

Sphrodolestes and Hiranetis braconoformis assassin bugs: mimic a range of wasp species.

Scaphura katydids: mimic the appearance and movements of a wasp when disturbed.

Arctiid moths: mimic the appearance of wasps.

Paraluteris prionurus: this small leatherjacket mimics the shape and colour patterns of the poisonous *Canthigaster valentini* puffer-fish.

D&M Photuris Mimicry

Photuris - Fireflies: north American fireflies of the *Photuris* species employ modulation of their light flashes to attract mates.

- Females of a number of species are known to alter their modulations to mimic closely related species, in order to lure males of these species as prey.
- Stous (1997) notes that "*Photuris versicolor* is known to prey on eleven species of firefly, and twelve other *Photuris* species prey on at least two, or more, species. One prey species in Florida has 6 predators ... ".
- The behaviours include luring other species close enough to perform an aerial attack, or hovering in the vicinity of a female which is signalling to ambush arriving males.

Wasp Mimicry (D&M) - Arctiid Moth

(©John Himmelman, www.connecticutmoths.com)

Wasp Mimicry (D&M) - Sesiidae Moth

(©Dexter Sear, IO Vision, www.insects.org)

Wasp Mimicry (D&M) - Assassin Bug

(Microsoft Encarta 96 Encyclopedia. ©1993-1995 Microsoft Corporation)

Wasp Mimicry (D&M) - Katydid

(Philip K. Wittman, www.canopyaccess.com)

Wasp Mimicry (D&M) - Native Bee

(Hyleoidis Concinna - ©Australian Native Bee Research Centre www.zeta.org.au/ anbrc/)

Examples of D&D/Denial (1) Strategy

Techniques which disable or impair the basic function of an opponent's sensory apparatus or 'receiver'. Noxious fluid discharges or aerosols which can irritate another specie's olfactory or taste sensor or eyes represent good examples.

Stink Bugs: a very wide range of stink bug species exist. When disturbed, these typically release a foul aerosol which impairs the predator's olfactory sense.

Blattodea - Cockroaches: a number of cockroach species will spray a noxious fluid when disturbed, again to impair the olfactory sense of the victim.

Anisomorpha buprestoides: this North American walkingstick insect will spray an irritant fluid into the eyes of a predator if threatened.

Chem Agent (D&D) - Blattodea

(Skunk Roach - Eurycotis Floridana, ©www.bugsincyberspace.com)

Examples of SUB/Denial (2) Strategy

Subversion is not as frequently used as the other three canonical strategies. As it is more complex to execute, this might explain why it is less common than simpler strategies.

Cuculus canorus: The cuckoos subvert the nervous system of the host parent, in order to addict it to the feeding of the cuckoo.

Bothriomyrmex regicidus and decapitans: Queens of these 'cuckoo' ant species will invade another ant colony, kill the queen and seduce the colony worker ants into rearing the usurper's brood.

Monomorium sanschii: Queens of this 'cuckoo' ant species will will invade another ant colony and emit a chemical which alters the behaviour of the victim ants. These will attack and kill their own queen, adopting the invader as their new queen.

Conclusions

- Against the three test criteria we defined to establish that these strategies are indeed evolved features of species, many examples were easily and quickly found.
- The hypothesis of 'Information Warfare being an evolved survival mechanism in nature' can be proved by a large number of examples.
- IW is therefore a very *fundamental* paradigm, which has been part of nature for hundreds of millions of years.
- Future research (1): What role might have been played by IW in the evolution of human intelligence?
- Future research (2): Can modern IW technique benefit from the study of biological implementations of IW?

End Presentation

Revision Information

This document is currently at revision level:

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