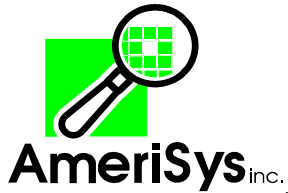


GERDCSTM

The Geographic Electromagnetic Radiation Domain Control System

A system used to promote frequency reuse,
plan for coexistence between
licensed and license-exempt spectrum users,
determine spectrum availability
and
efficiently convey needed information in a timely manner.

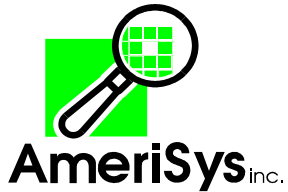


Audience



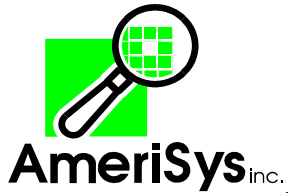
- **Regulators**
- **Transmitter operators**
 - Licensed incumbents
 - License-exempt
- **Network planners**
- **Emergency response personnel**





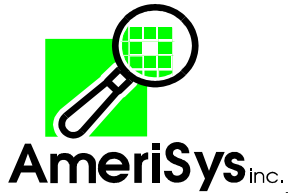
Scalable Distributed or Centralized Model

- **The proposed system is a set of interconnected services**
 - In a single device or in an intranet or internet of networked of devices
- **Consisting of at least one instance of each of the following**
 - Spectrum User (SU) - transmitting/receiving device
 - Coexistence Enabler (CE)
 - Coexistence Database Server (CDS), SQL Server, DNS Server
- **With optional operation enhancement servers**
 - AAA & Radius Server
 - TV White Space (TVWS) regulatory Server
 - Geographic/Topographic Resolver (GR)
 - Topographic Database Server



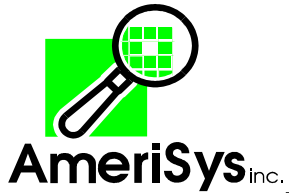
Environment

- **Similar in nature to**
 - The Internet Domain Name System (DNS)
 - That resolves names (URLs) to IP addresses
- **Intends to comply with the needs expressed in**
 - 22-06-0242-09-0002-draft-recommended-practice.doc
 - 19-10-0055-03-0001-system-design-document.pdf
 - With alterations avoiding what WISPs perceive as unacceptable pitfalls

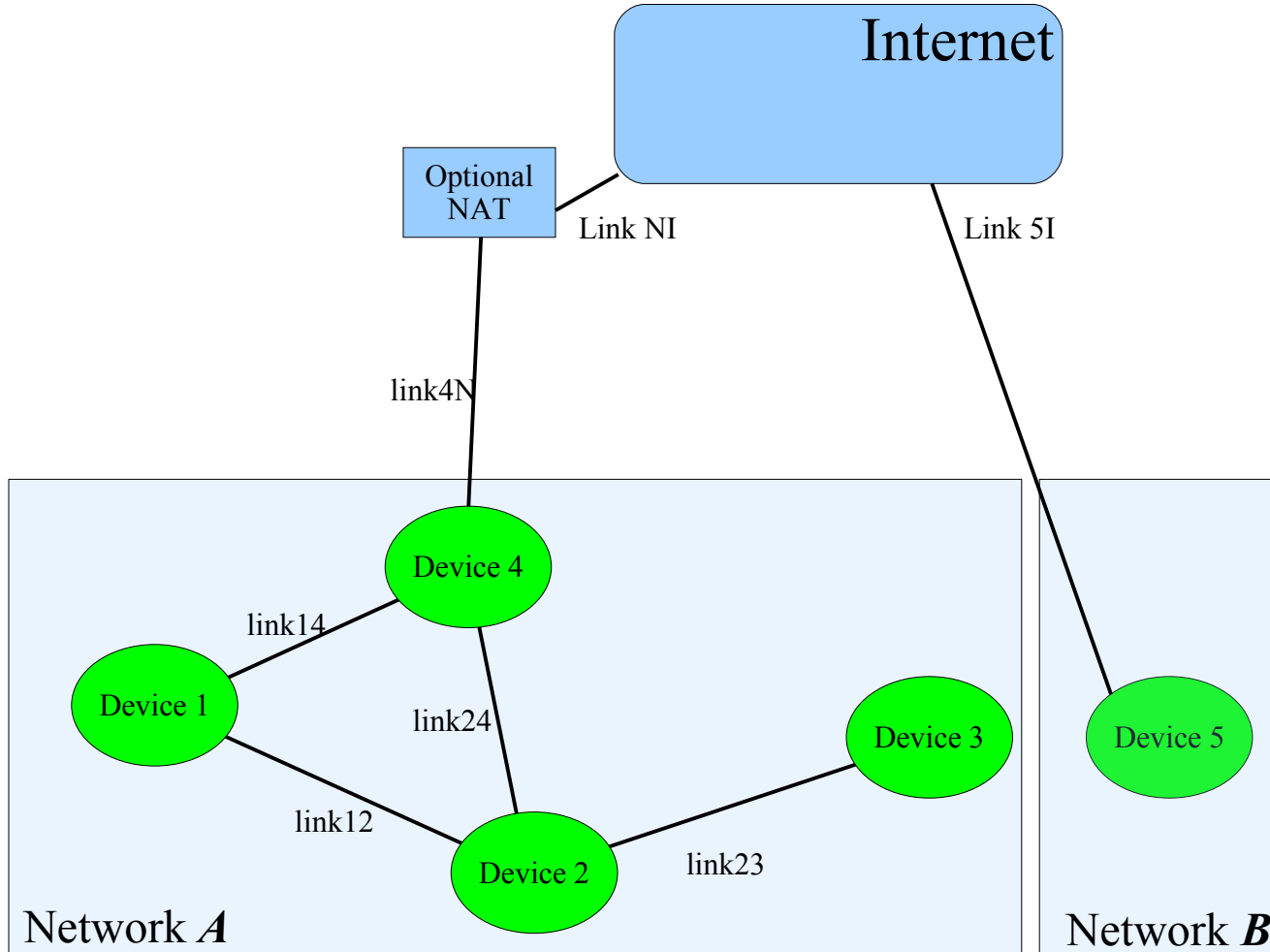


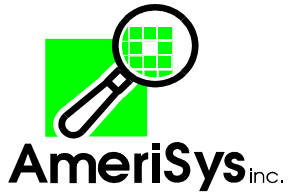
Semantics I

- Throughout this document, a **network** is defined as
 - a set of devices with zero or more links allowing the devices to communicate with each other
- A **device** is either
 - a physical object exhibiting a specific behavior
 - an instantiation of a service within one or more physical objects
- A **link** is a point-to-point means of communication between two devices
 - Multiple links may conglomerate to form link sets
 - in a point to multi-point fashion
 - In a multi-point to multi-point fashion



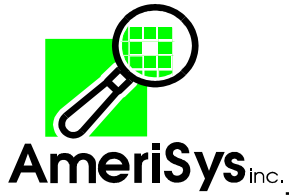
Example Topology Semantics I



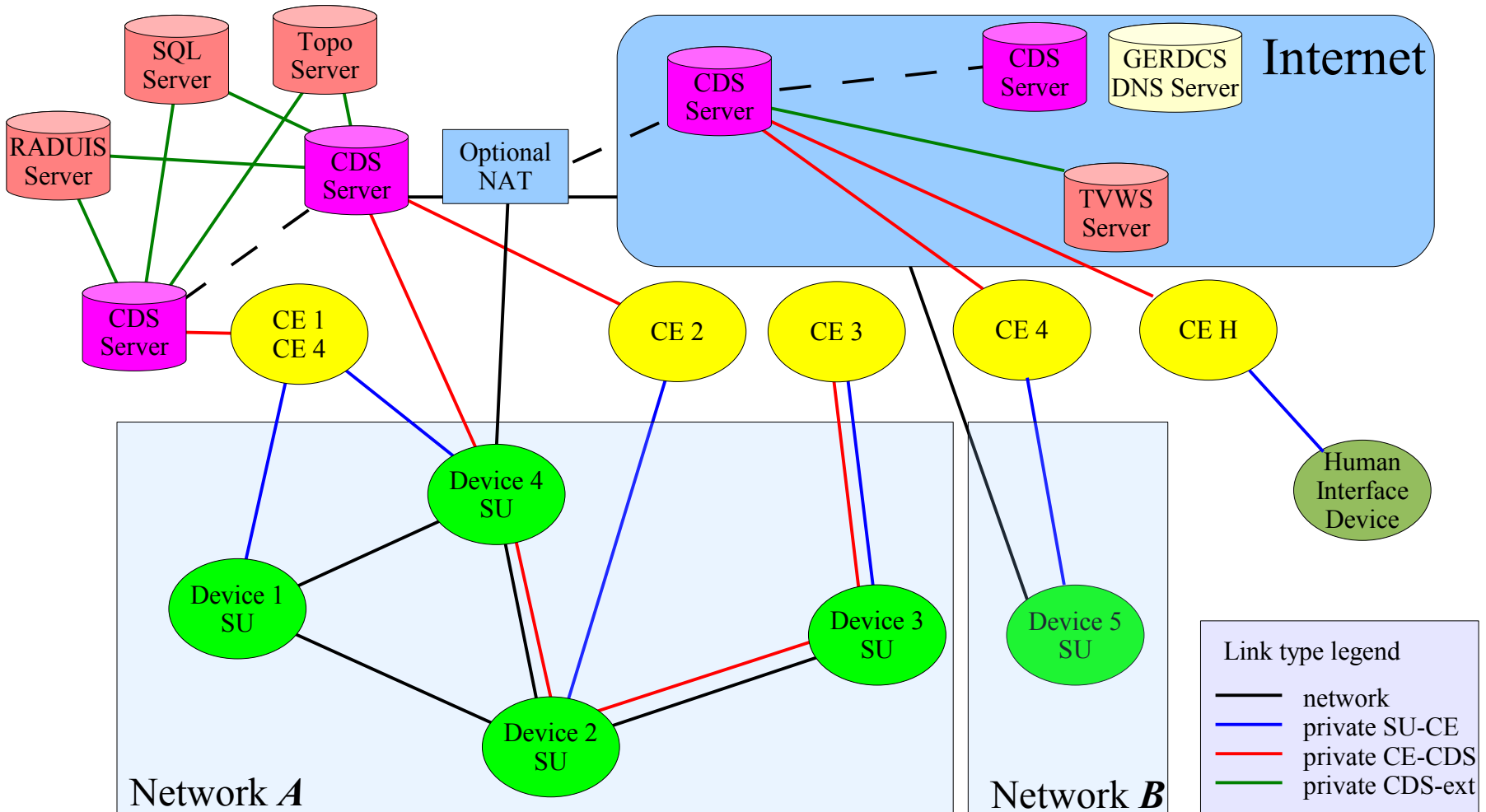


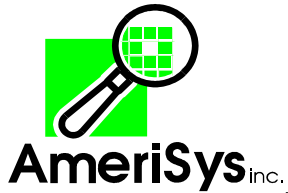
Semantics II

- A **coexistence enabler** (CE) is a service that
 - Interfaces devices to a CDS
 - Normally situated in or communicating with
 - Stations or CPEs, Access Points or Base Stations
- A **coexistence database server** (CDS) is a service that
 - May performs AAA (authentication, authorization, accounting)
 - Encapsulates and protects the SQL database integrity
 - Securely communicates with
 - CE
 - SQL databases, RADUIS databases, TVWS database, etc...
 - Recognizes and traverses NAT firewalls when required
 - Acts as firewall between CE
 - Provides required communications
 - Protects CE privacy (if needed)

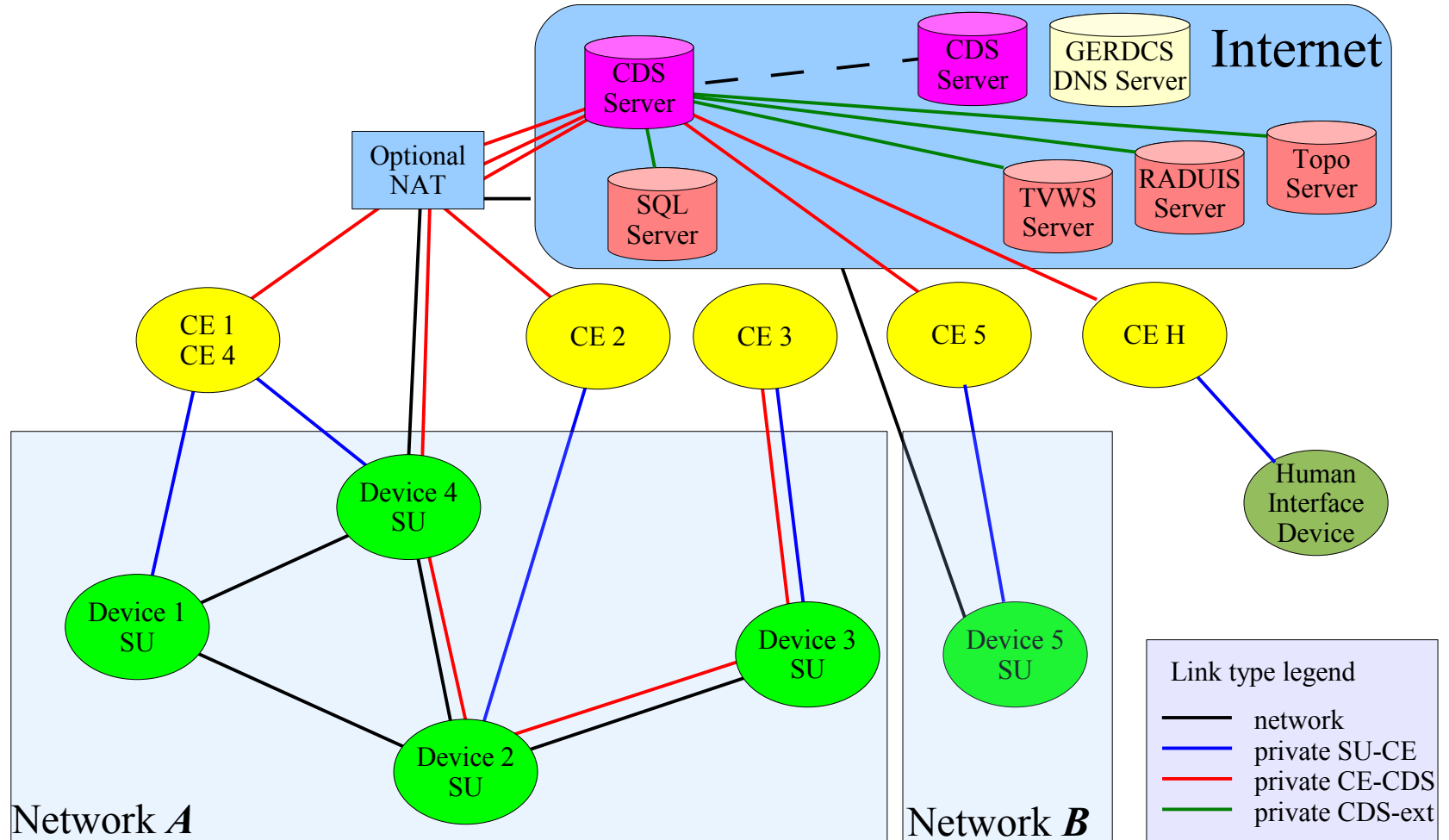


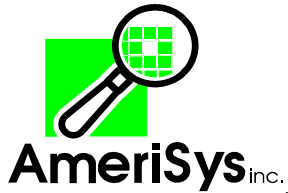
Example Topology Semantics IIa





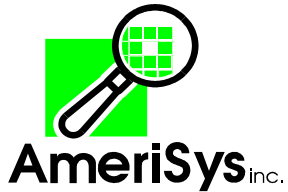
Example Topology Semantics IIb





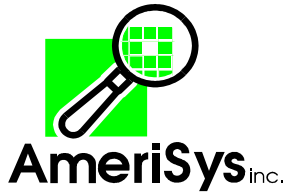
Propagation Conditions

- **GERDCS provides for terrain and vegetation**
 - With the addition of a GR and topography servers
 - may take into account
 - Terrain topography
 - Radio propagation conditions



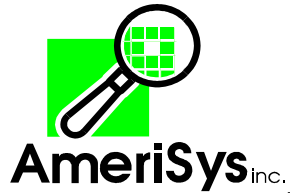
CE functions

- Monitors devices
- Interacts with the CDS
 - Announces to the CDS
 - Device ID & presence
 - Condition changes
 - Receives, processes and responds to CDS queries
 - Effects changes to devices in their specific terms
- May provide limited support of
 - Foreign devices
 - Legacy devices



Coexistence Database Server Functions

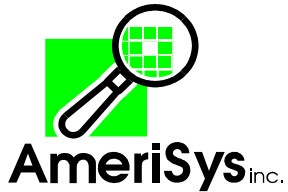
- Act as a proxy
- Allow controlled communication
 - Between otherwise anonymous devices
 - Via an information storage and an exchange of queries and responses
- Provide the essential links
 - Between CE
 - Other CDS
 - To databases such as topographical and TVWS databases
- Analyze the information to improve coexistence situations
- Provide CE with information and recommended actions
- Become aware of the device's compliance to the recommended actions and further disseminate recommended actions to optimize coexistence



Global Access

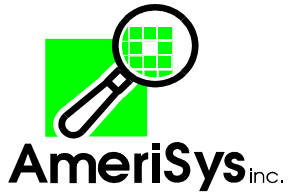
- The coexistence database server(s)
 - Each server having a globally accessible URL and service port
 - Supporting defined dialogs under the SSH and/or TLS protocols
 - All required information for coexistence shall be openly accessible
 - As per policies to be defined within 802.19
 - To 802.19.1 CE





Global Access

- The CDS
 - Shall publish their public URL with all known peer devices in a limited geographical area
 - Such as to enable discovery and exchange of information on an ongoing basis
 - Shall publish all known peer database enabled service public URLs
 - Such as to propagate and disseminate known public database enabled service URLs to all peer devices.
 - Database enabled public URLs shall be in a text format specifying latitude, longitude and coverage to allow for traffic-free filtering

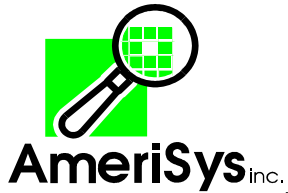


Goals



- **Help in resolving coexistence issues**
 - Help to protect licensed operators
 - Inform license-exempt operators
- **Provide an efficient communication system**
- **Proactive and effective**
- **At quickly disseminating notifications and**
- **Propagating data in a scalable fashion**
- **With multiple interfaces**
 - machine to machine
 - human-machine



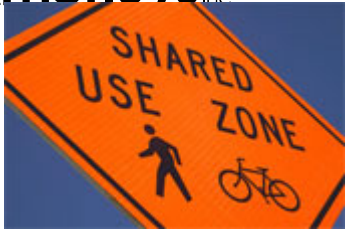


Scope

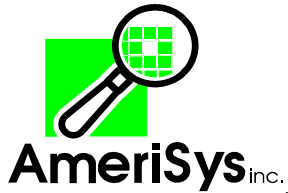
- **GERDCS is not**
 - A coexistence assurance system
 - A dispute resolution system
- **GERDCS allows uniform communication**
 - enhancing operator awareness



Awareness



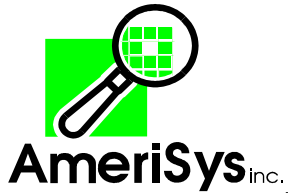
- **Helps to avoid and resolve coexistence issues**
 - Between license-exempt operators
- **Help to protect licensed operators**
 - From license-exempt operators



CDS Function

- **GERDCS receives, validates, conveys and disseminates**
 - data pertaining to the maximum radiation levels
 - a license-exempt transmitter or
 - an array of Same Frequency Network transmitters
 - should be allowed to impress on a victim receiver
 - at a given time and location
 - before such radiation starts to cause
 - significant degradation to the receiver's ability
 - to receive and decode another signal

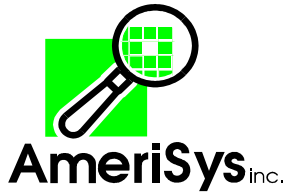




GERDCS

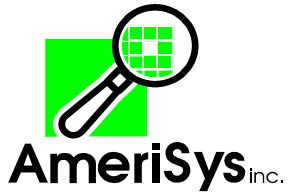
- **Is designed from the ground up to**
 - Allow for enhanced coexistence
 - Subjugate license-exempt services to
 - Regulatory requirements
 - Licensed incumbents
 - Provide for voluntary coordination
 - Between transmitter operators
 - Protect information confidentiality
 - Provide usage logs and audit trails
 - Provide information source identity





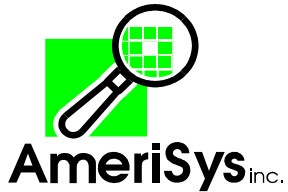
GERDCS Concern for Privacy

- **CE may request information**
 - For whatever reason
 - For entire geographical areas
 - Irrespective of whether they actually have
 - Transmitters or receivers in that area
 - Without divulging
 - How many they may have or where they are
- **As the request covers a geographical area**
 - It does not divulge
 - Quantities or location of transmitters and receivers
 - Circumventing WISP operator objections
 - Of divulging their network topology and BS locations



Geographic Resolver

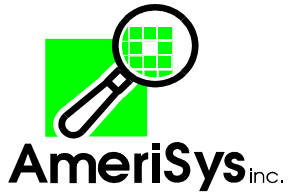
- **A Geographic Resolver (GR) is a GERDCS client device**
- **It runs under the exclusive supervision of an operator**
 - Of a transmitter
 - Of a network of transmitters
- **May be used by a network designer**
 - Seeking for optimum future transmitter locations
 - In the potential evaluation of available sites



Geographic Resolver

- **Requests**
 - Secure GERDCS client-server connections
 - Queries GERDCS servers
 - Receives responses and notifications
- **Transmitter operators**
 - who want to operate and coexist
 - use a resolver to assess
 - if a channel is cleared for use and available

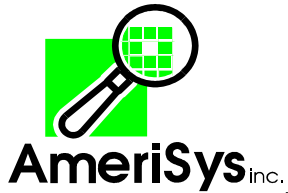




Geographic Resolver

- **One of its tasks and responsibilities is**
 - To receive and analyze
 - Specific bandwidth allocation requests
 - Made by the transmitter operator
- **It analyzes and resolves**
 - local transmitter geographic electromagnetic radiation coexistence issues
 - in a given geographic reception area
 - based on
 - available data
 - established rules and agreements

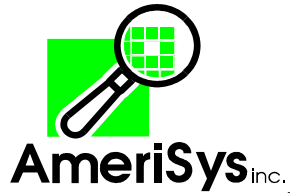




Geographic Resolver

- **The result of this analysis is**
 - A matrix of maximum allowable field strength vectors
- **This time-bound matrix covers the entire geographic area the transmitted field may reach**
 - Including direct paths, reflection, etc...
- **This multi-dimensional matrix has indexes of**
 - Time
 - Position
 - Polarization
 - Incident arrival angle

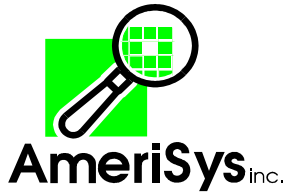




Antennas

- **Transmitter and receiver antennas**
- **Have complex multi-dimensional free-space radiation patterns**

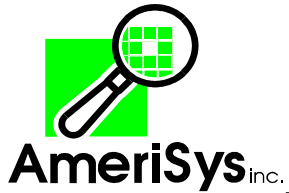




Geographic Resolver

- **The resolver as a cognitive system device**
- **Knows a-priori about**
 - The transmitter's antenna properties
 - Surrounding terrain propagation characteristics
- **It considers all these factors and determines the maximum allowable EIRP and field strengths emanating from the transmitting antenna in the determination of the maximum allowable radiated power a given transmitter may emit**

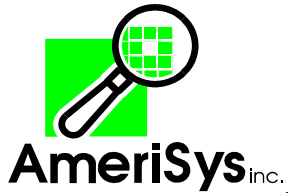




Geographic Resolver

- **The output of the resolver is the maximum allowable output power in dBm over a requested frequency range and operating period**
- **The resolver, requesting and maintaining active connections also receives and reacts to pro-active GERDCS environmental change notifications**

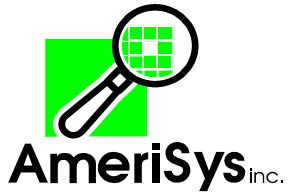




GERDCS

- **GERDCS is like a dynamic road sign**
- **In itself, it does not enforce or ensure rule enforcement**
- **It provides a common framework**
- **It disseminates information**
- **Allowing law-abiding citizens to make informed decisions to comply with complex requirements**
- **Negates ignorance as a plea or excuse for non-compliance**
- **Its an evolutionary system which will doubtlessly evolve with time**





GERDCS

- **Transmitter operators are responsible**
 - To limit claims sensibly to and only to their legal rights
 - With traceability and recorded audit trails
 - To be courteous bandwidth sharers
 - To comply to regulatory requirements

