Management of Telemetric Network Systems

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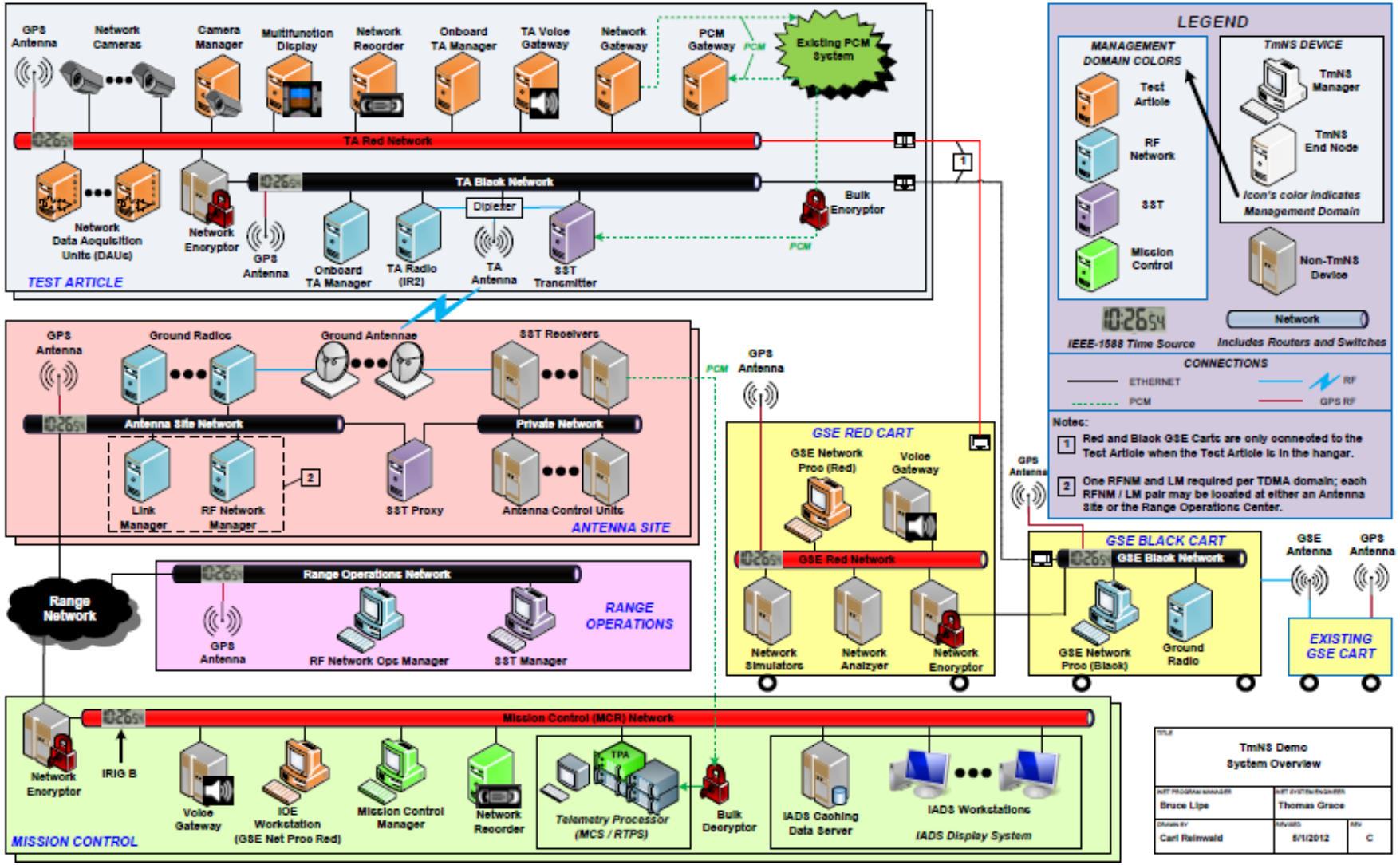
System Architecture



TmNS Message Flows

- Three basic types of flows in system
  - All use the same communication pathway
- Management
  - Used for configuring, statusing, and reporting
- Time
  - Distribution of time through the network
- IP Data (Measurements)
  - Two delivery mechanisms defined
    - Latency/Throughput Critical Data
      - Connectionless service
    - Reliability Critical Data
      - Connection oriented service

General Concepts

- Manages Network Devices
  - Switches, Routers, Radios, Antennas, Data Acquisition Units, Recorders, etc.
- Configures Test
  - Device settings and policies/rules
  - Establish data flows through the system
- Provides Test Status
  - Data flow status, Data rates, Device health, etc.
- Communicates Errors and Warnings
  - Data overflows, Time source errors, Link issues, Devices issues, etc.
- Control of Peripherals
  - Control recorders, data sources, data sink

All Remotely in a Standardized Way!

Management Functions

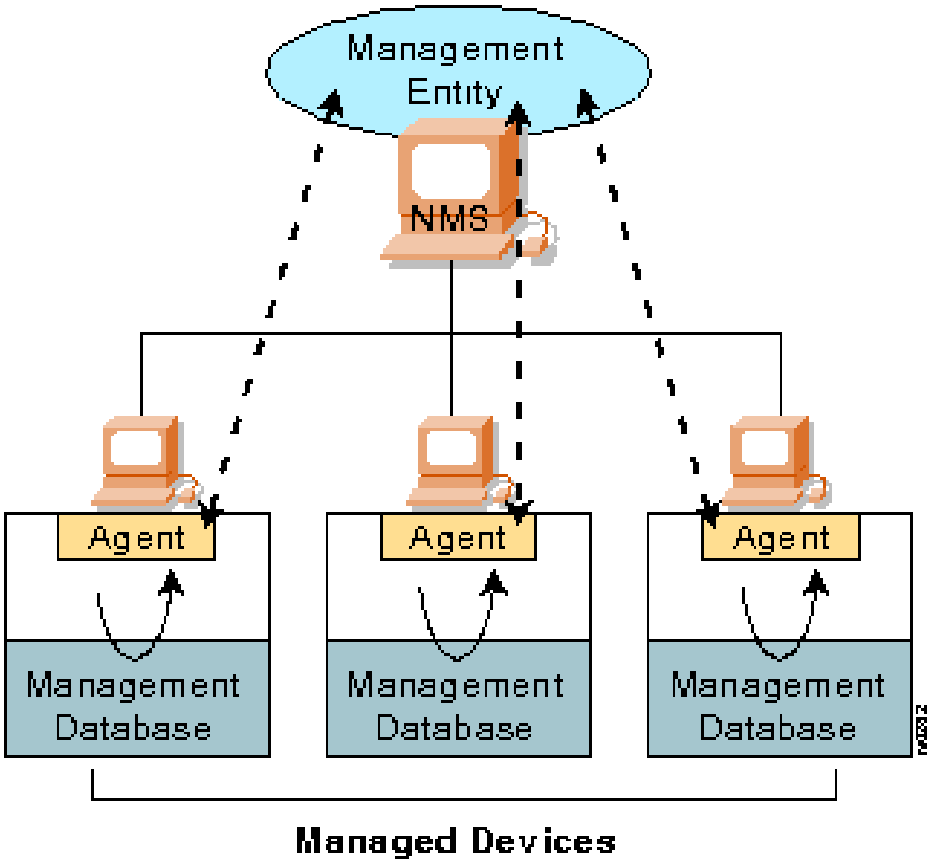
- Designed to simplify the operation of large networks; this includes:
  - controls strategic assets from a central position
  - aids in strategically planning for network growth
  - provides remote system management
  - operates independently of the system it monitors
  - supports multiple protocols
  - operates as transparently as possible
  - improves services
    - maintaining network stability
    - tuning network performance
  - balance various needs
    - including applications, systems, and technologies
  - troubleshooting problems that might arise
  - reduce downtime with fast response time
  - control costs

Management System Model

- A typical model of system management systems consists of:
  - a manager (s)
    - the central controller
  - the managed device
    - network devices like routers and gateways which interconnect sub-networks
  - a protocol for communications
    - between network devices and the controller
    - a set of parameters to be monitored and controlled

Components of a Management System

- Manager (s)
- Managed Device
  - agent
  - management database
- Management protocol

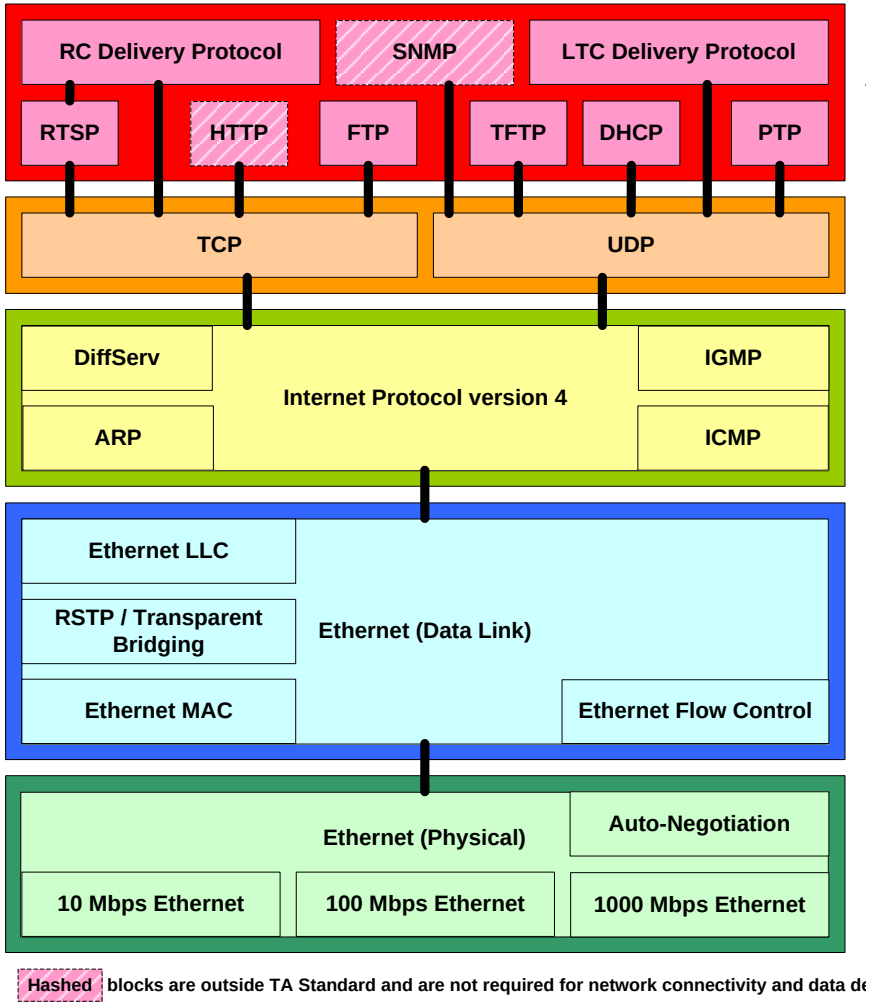


Protocols

- Protocols
  - SNMP – Simple Network Management Protocol
    - Controlling, Querying, and Events
  - HTTP – Hypertext Transfer Protocol
    - Device specific inquiries, Detail troubleshooting
  - FTP – File Transfer Protocol
    - Configuration
  - ICMP -- Internet Control Message Protocol
    - Device discovery, basic troubleshooting
  - Custom Messaging
    - RAN Messaging
- Management
  - Commands
    - Controlling -- Configuration, Enabling, etc.
  - Queries
    - Statusing/Heath monitoring -- Identification, Faults, etc.
  - Events
    - Self Reporting -- Informs, Traps, etc.

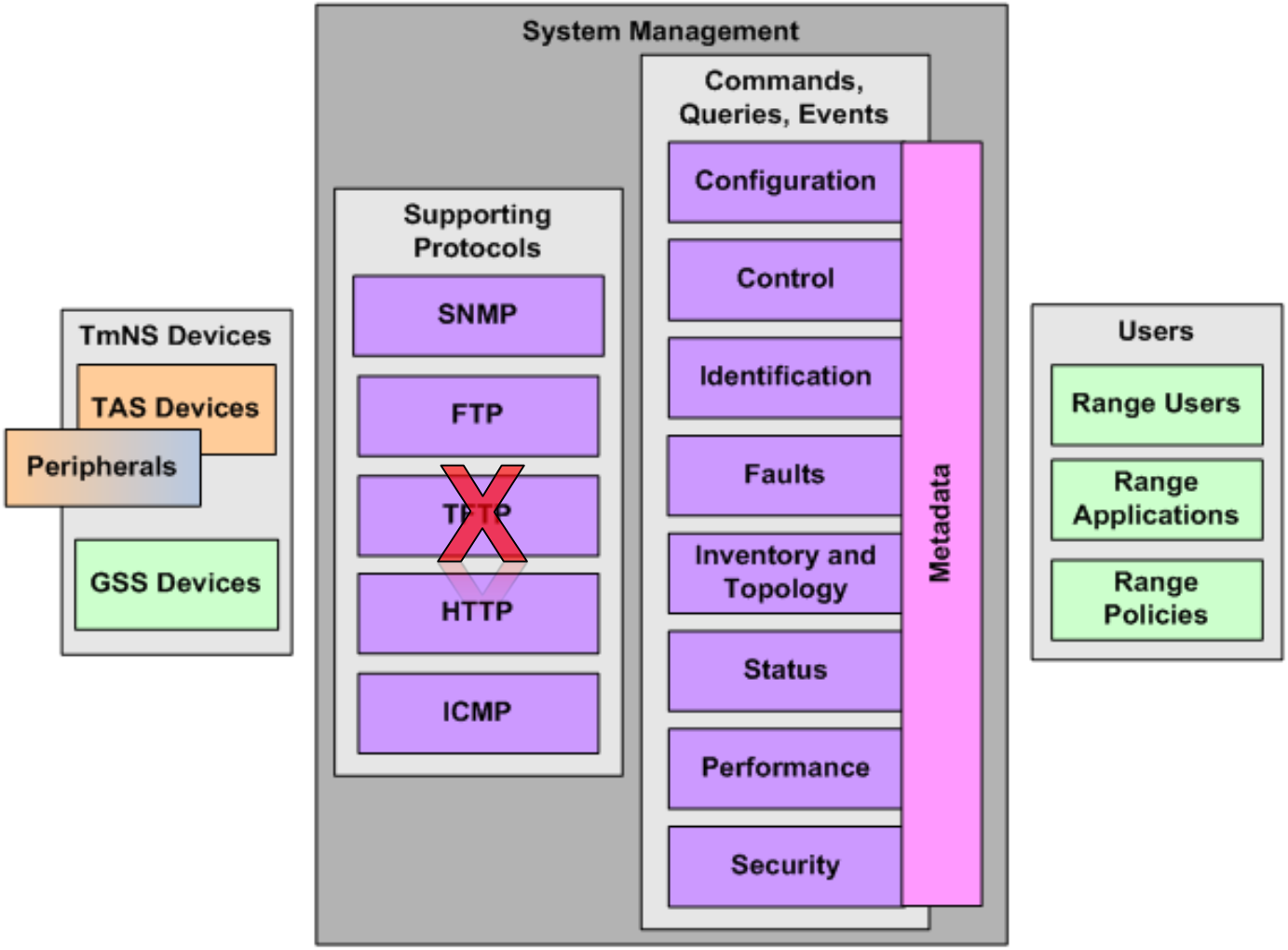
Test Article Standard Technology Picture

RAN Messaging



OSI Model	Internet Model
Applications Presentation Session	Applications
Transport	Transport
Network	Internet
Data Link Physical	Network Interface

System Management Standard Technology Picture



Metadata for Management

- Documentation
  - Information that describes a test system
    - Describe test requirements
    - Describe the design of a test system
    - Describe the configuration of the test system
      - instrumentation, telemetry, network equipment, etc.
    - Describe how test data is formatted, encapsulated, and stored
- Metadata Usage
  - Metadata describing the configuration information in a common language and documented in a standard file structure will:
    - Allow a system manager application to configure the networks and devices for basic network interoperability
    - Metadata will be consumed by the telemetry devices to configure the network interfaces for a test
  - Metadata will describe the network data formats to ground system application that will extract measurements from data flows, or otherwise consume test data flows

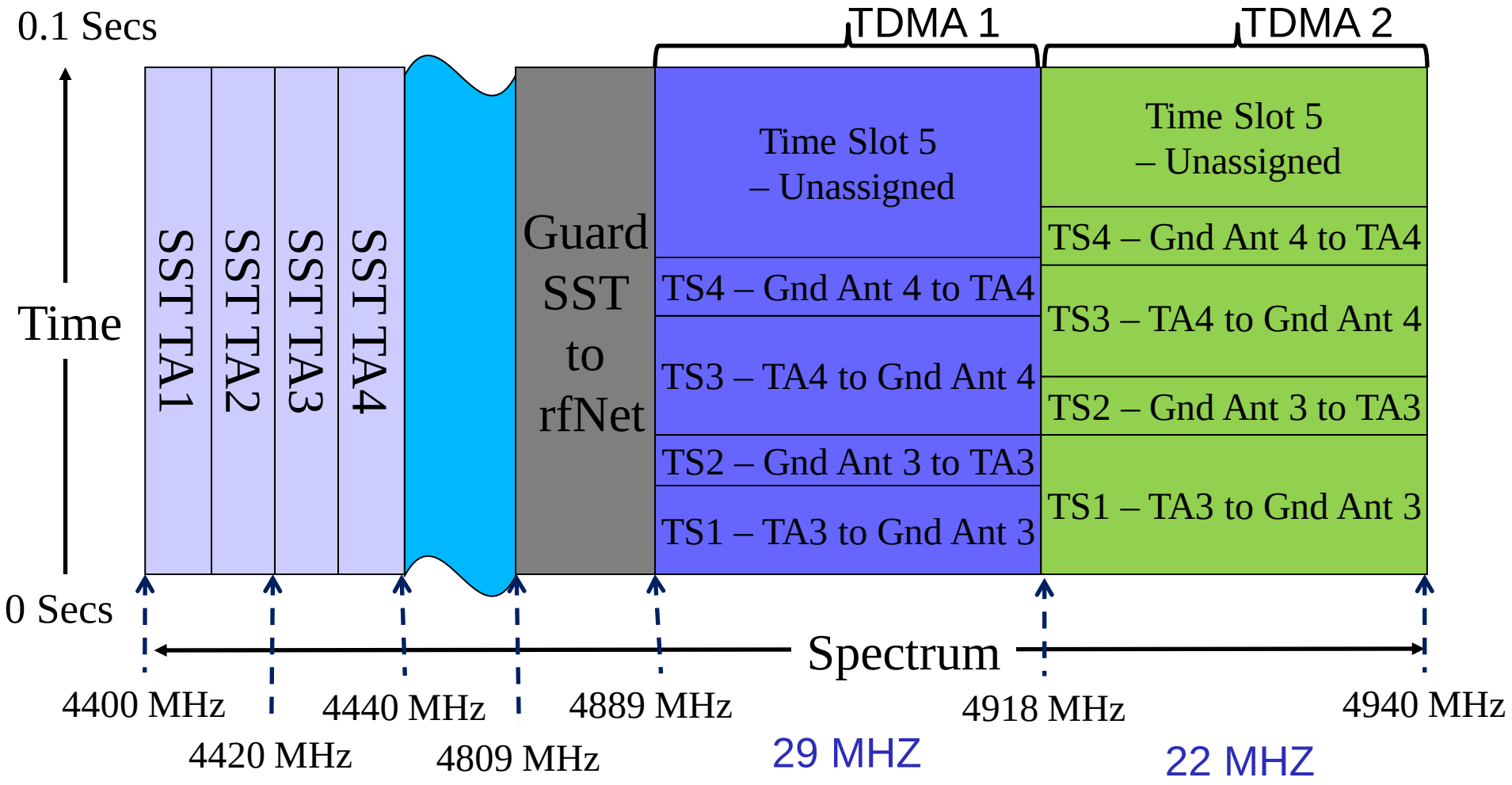
Peripheral Management

- Data Acquisition
  - Configures devices to acquire data
  - Setup the delivery mechanisms
    - Includes Quality of Service markings
  - Status Reports
    - Provides statics
      - Data Rates
- Data Recording
  - Configures data to record
  - Configures data for retrieval
  - Setup the delivery mechanisms
    - Includes Quality of Service markings
  - Status Reports
    - Provides statics
      - Session Status
      - Data rates,

RF Link Management

- Radios
  - Configuration
    - Device setup
      - Center frequency, Radio Address, IP address, Routing, etc.
    - Configures data flows
      - Establishment of Radio Bearers
      - Priority based on Quality of Service markings
  - Control
    - Enable/disable, reset, etc.
  - Status Reports
    - Provides statics
      - Link state, utilization, data rates, dropped packets, errors, network topology, connected nodes, etc.
- Other considerations for Radio Access Network
  - TDMA parameters
    - Slot time and Slot allocation
    - Frame gaps and guard times
  - Power control
    - How far am I from my Hub?
  - Antenna control
    - Where am I pointing in relationship to the test article?

Spectrum Resource Management



Other Considerations

- Spectrum use must be coordinated among test articles
- Spectrum use must be coordinated among test ranges
  - Range to Range handoff
  - Ranges with spectral overlap
- QoS requirements of a test article are dynamic based on data telemetry requirements
- Spectrum needs of a test article depend on its QoS requirements
- Status monitoring of Spectrum resource parameters required to determine system health and provide feedback for control

QoS in Networks

- The Internet was not designed with QoS in mind
  - IP is a best effort, connectionless protocol
- QoS support is beginning to hit “critical mass”
  - Networks are fast enough
  - QoS protocols are rapidly maturing
    - becoming standardized
    - supported by network switches, routers,
    - supported by host software
- Modern internets have many QoS options
  - Differentiated Services (DiffServ)
    - Defines “Class of Service”
    - Map multiple individual data streams to a certain class based on the delivery guarantees needed
    - Routers process packets class-by-class rather than individually

TmNS QoS Assignment

IEEE 802.1Q PCP – IEEE P802.1p	DSCP Category Description	Expected TmNS Use
0 – Best Effort	Best Effort	DSCP 0: General Network Traffic (e.g. FTP)
1 – Background	Class 1	DSCP 8: RC Delivery at Normal Priority & System Management Status
2 – Excellent Effort	Class 2	DSCP 16: LTC Delivery
3 – Critical Applications	Class 3	DSCP 24: RC Delivery at High Priority
4 – "Video," < 100 ms latency & jitter	Class 4	DSCP 32: System Management Control & Video
5 – "Voice," < 10 ms latency and jitter	Expedited Forwarding (EF)	DSCP 40: Voice
6 – Internetwork Control	Control (used for IP routing protocols)	DSCP 48: RAN Messages
7 – Network Control	Control (link layer and routing protocol keep alive)	DSCP 56: Link Manager Messages

Summary

- TmNS provides a standardized way to leverage commercial technologies
- IP networking is the core technology with its complement of supporting technologies/protocols
- TmNS has some performance issues beyond standard IP networking
  - iNET standardized approach addresses these challenges
- Management of Telemetric Network Systems encourages uniform processes for conducting flight tests

Questions?

Thank You!