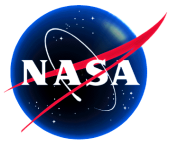

Modem Link-Property Advertisements

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Dan Shell
Daniel Floreani
Rajiv Asati

Cognitive Networks and Radios

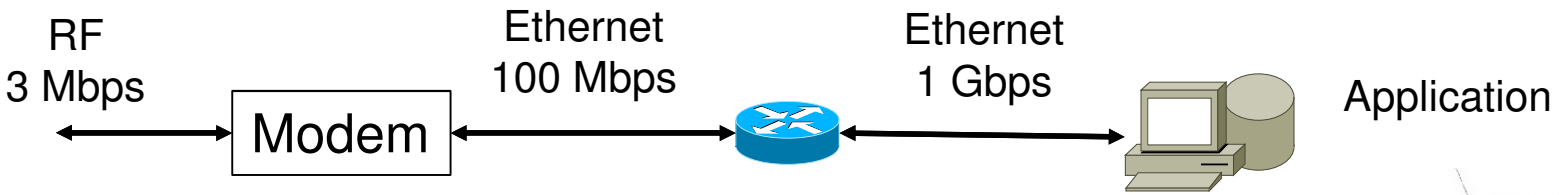
- Autonomous system – perceives current conditions, and then plans, decides, and acts on those conditions based on predefined rules and algorithms.

- Cognitive system – **LEARNS** from the consequences of its actions and uses this knowledge to improve the future decisions (instead of just predefined rules/algorithms)
  - Feedback is required
  - Need to establish good metrics
  - Learning takes time

- Radio Networks should be cognitive for true adaptability and dynamism and be aware of its environment.
  - Thus, technologies must be developed that expose radio parameters to rest of network and provide methods for adjusting those parameters.
    - Example - Modem Link-Property Advertisements

Smart Modems

- Modem's transmitting and receiving link rates can be varied over time due to the following:
  - Adaptive coding
  - Changes in Modulation to suit radio channel characteristics.
  - Changes in transmission rate to suit radio channel characteristics
- Rate mismatch between RF link and Ethernet link.
  - Serial connections are less of a problem as clocks can be controlled by modem (at least the receiving clock)
  - Ethernet connections are becoming standard and result in rate mismatch between the LAN interface and the RF link.



Issue / Problem

- To condition traffic and get the most out of the modem's link capacity, routers & applications need to know the modem's link conditions.
  - Figure 1 corresponds to existing commercial imaging satellites
  - Figure 2 is more generic
- Desire is to have a standard method for the upstream devices (router and host applications) to learn of the link conditions and adjust
  - Link Up/Down
  - Link Unreliable
  - Data Rates

Figure 1

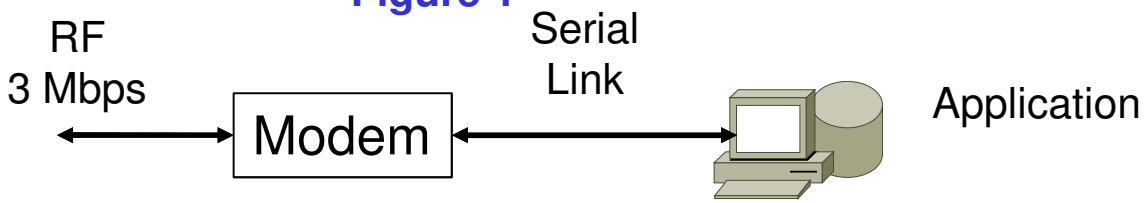
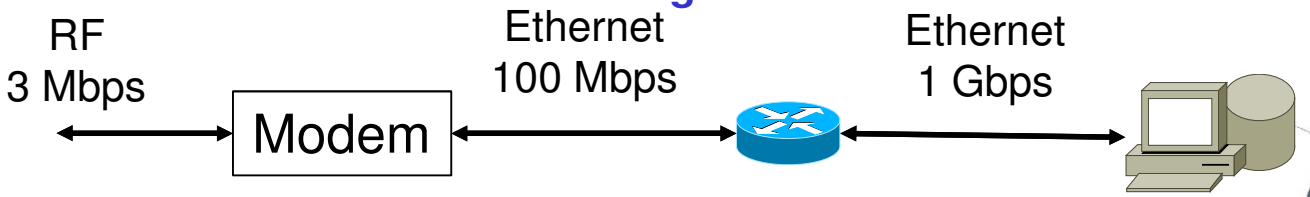
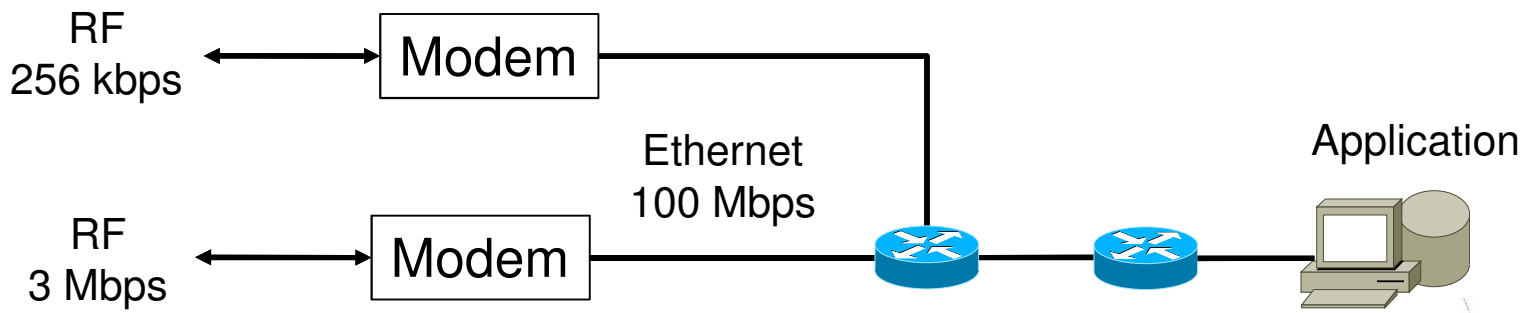


Figure 2



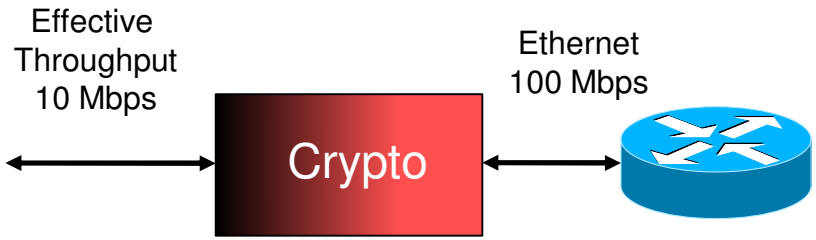
Solution

- Develop a standard protocol that provides link status conditions
  - Should be able to provide wide area network (WAN) radio reachback link status to routers and upstream devices/applications that may be multiple hops away.
- Uses
  - Applications can adjust to link state
  - Route Optimization
    - Useful for multi-homed systems



Crypto/Router

- Red/Black Separation
- Rate Mismatch Problem
- It is hard to sense the real rates offered through “the system”.
  - It is feasible for such devices to work this out on their black side - and the red side and can simply advertise the "offered rate".
  - The Black side obtains knowledge of its downstream link state via modem advertisements, router advertisements, or probes, and pass this on to the red side via approved methods.
  - The red side can then advertise its rate via the LPA protocol.



Strategy

- Released public request for participation to radio system providers and information system manufacturers
- Starting Points
  - RFC-5578, PPP over Ethernet (PPPoE) Extensions for Credit Flow and Link Metrics
    - Informative Document
    - Similar idea, but very complex with too many parameters that cannot be set well.
  - Dynamic Link Exchange Protocol (DLEP) (draft-ietf-manet-dlep-00)
    - Similar to RFC-5578, but does not utilize PPPoE
    - Router-centric
    - Session-oriented
  - Link properties advertisement from modem to router (draft-wood-dna-link-properties-advertisement-01)
    - Uses UDP multicast to advertise link characteristics
    - Simple
- Demonstrate usability in C or C++ implementation of Saratoga
  - Listen for information on multicast channel to set rate-limit
  - Can test in Global Hawk Protocol Testbed.

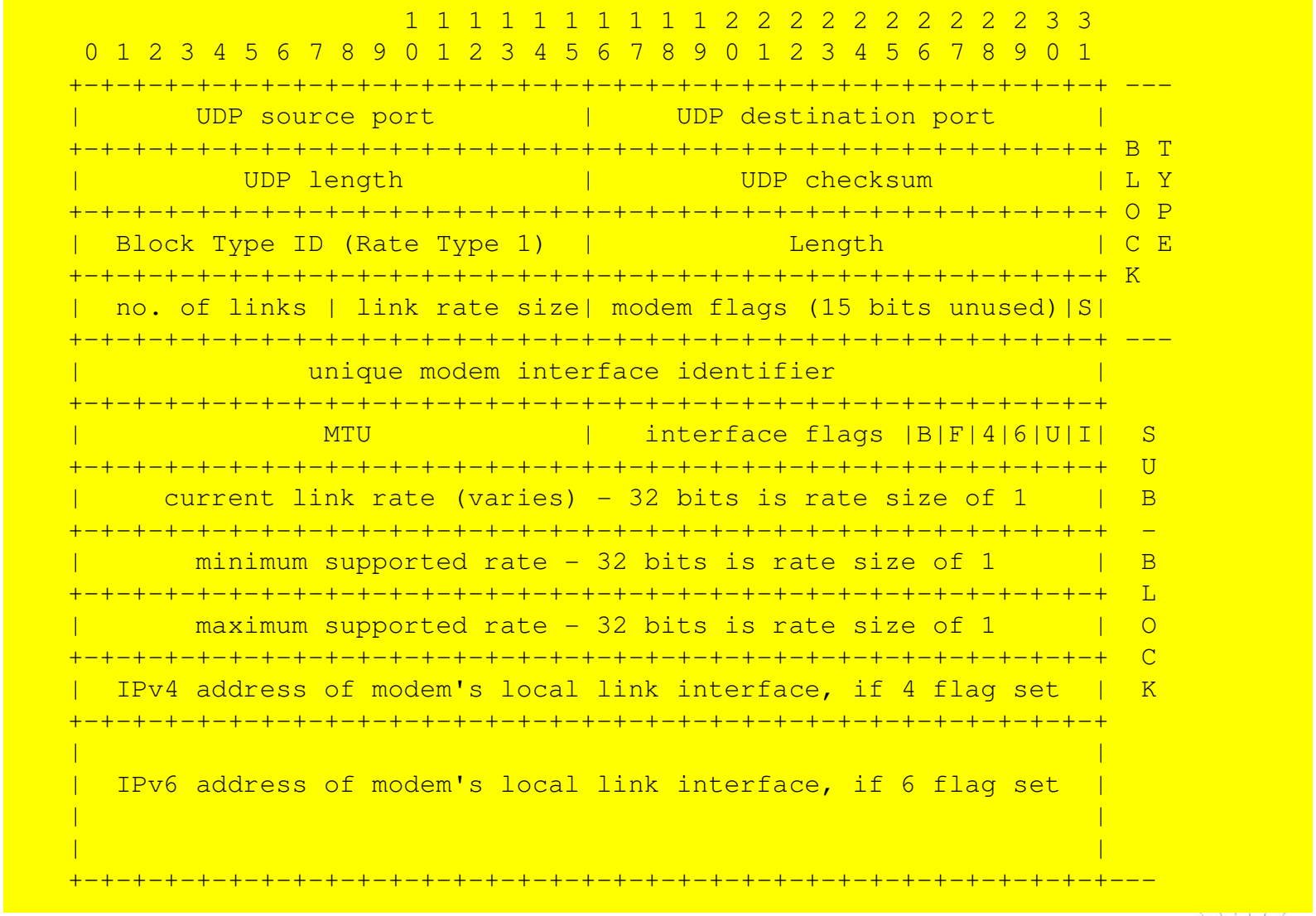
Protocol Concepts

- Advertise Modem's link conditions over IP/UDP
  - Link-local IP multicast advertisements from Modem
    - No need for client/server configurations
    - Requires no explicit configuration setup to provide information to connected devices.
    - Easy to deploy
- Advertise link properties to upstream systems.
  - IPv4 organizational-scoped multicast and IPv6 site-local multicast
    - Requires multicast to be enabled in network
    - Requires approval of a new organizational/site-local multicast type by the Internet Assigned Number Authority (IANA).
    - Misconfigurations of organizational-scoped or site-local multicast could result in advertisements in unforeseen global traffic.
  - Unicast advertisements
    - Requires configuration in the modem to send advertisements to known endpoints.

Protocol Signaling

- Advertisements are sent periodically or as notifications of link-layer events (such as rate changes) when they happen
  - A link rate changes due to a coding change, or the link and its interface go up or down
- The modem should send periodic advertisements about link conditions, in case new devices have been connected
- A device attached to the local link must be able to receive link property advertisements via UDP/IP packets sent to the "all routers" multicast address.
- Other network-attached devices may receive advertisements via IPv4 organizational-scoped multicast and IPv6 site-local multicast or unicast advertisements.

Protocol Block Type



Rate Block

- Currently, only one Block Type has been considered, the Rate Block [Slide 11]. Key components of this block type are:
  - The maximum data rate is defined by a 32-bit word corresponding to a limit of 4 Gbps.
  - This format enables one to specify link characteristics simultaneously for both link directions, or separately for the incoming and outgoing links.
  - Link Up / Link Down information is conveyed via the interface flag “U”.
- Other possible blocks, not yet defined here, could express measured error rate, current forward error-coding rate, latency (propagation delay, serialization delay), link MTU size, indicate link-level security mechanisms in use, or provide authentication.

Status

- Internet Draft submitted to Mobile Operations research group (mobopts)
  - Modem Link Properties Advertisement Protocol
    (draft-ivancic-mobopts-modemlpa-00)
    expires April 16, 2012
  - Why mobopts ➔ One research topic is to examination of the feasibility of generic mechanisms that allow tighter integration of the link layer with the IP layer for improving handover performance
  - Mobopts has not been very active lately and may recharter, but, this appears to be the most appropriate place to perform this activity

Collaborations

- Anyone or any organization interested in collaborating is welcome – particularly radio developers.
- Google Groups “modemLPA” formed
  - Maillist and archive
  - 13 current members
  - Open to any interested people
    - Contact Will Ivancic (william.d.ivancic@nasa.gov)
- Working with University of Akron
  - Packet Generation of modemLPA protocol for testing
  - Dissector for Wireshark®
  - Possible additions to NASA PERL implementation of *Saratoga*
- Working with Dr. Shaoen Wu of the University of Southern Mississippi
  - Rate Adaptation on Random Access Wireless Networking
  - Cognitive Wireless Networking Protocols

Summary

- We have presented a simple protocol that can be used to provide upstream devices and applications with downstream link conditions.
- The protocol in this document is described in the context of modem RF link properties, but can also be broadly applied to other scenarios such as cryptographic devices.
- The ability to sense and react to such information is critical for new and developing technologies such as cognitive radios and cognitive networks.