Introduction and Overview

NETWORK CODING RESEARCH GROUP – NWCRG (PROPOSED)

@ IETF 86 – Orlando, FL

11 March 2013

Brian Adamson   *– NRL*

Victor Firoiu   *– BAE Systems*

Agenda

1. NWCRG Overview (Victor / Brian) Provide brief overview of motivation, charter, history.

2. A view on placing network coding in the network (Muriel Medard, MIT).

3. Network Coding Research (Hamid R. Sadjadpour, UC Santa Cruz).

4. Content Network Coding on Androids: Energy Considerations (Joshua Joy, UCLA)

5. BRAVO – a practical, full implementation of a network coding system (Victor Firoiu, BAE Systems)

6. Overview of the Aalborg University Network Coding research and demonstrators (Frank H.P. Fitzek, Aalborg University)

7. Introduction to Kodo a cross-platform Network Coding Software Library (Morten V. Pedersen, Aalborg University)

8. Tetrys on-the-fly encoding: principles, results and demo (Jonathan Detchart, Institute Superieur de l'Aeronautique et de l'Espace - ISAE)

9. Discuss the Charter, who is interested to contribute and next steps

Introduction Outline

- Motivation
- Candidate Technical Areas
  - Architectural Considerations
  - End-to-end vs. hop-by-hop
  - Intra-flow and inter-flow
  - Application-layer
  - Service Paradigms
  - Security
  - Common algorithms, service descriptions, packet formats
- Proposed 2013 Activities
- IPR Notewell

Motivation: Research Advances

Research proved perf gains and practical algorithms

- Ahlswerde et al, 2000
  - Netcoding multicast achieves max flow-min cut
- S Li et al 2003
  - Linear coding w/ finite symbol size- sufficient for mcast
- Koetter, Medard 2003
  - Algebraic framework for linear network-coding
  - Min-cut max-flow achieved w time-invariant solutions for networks with delay and cycles.
- Ho et al 2003
  - Distributed randomized network-coding
- Lun et at 2005
  - coding scheme for reliable comm over packet networks
- And many others. Much research remains to be done.

Motivation: matured implementations

- Network coding has matured over the past decade or so of research
  - Full network coding systems have been demonstrated
  - Ready for more widespread, practical applications
- Network coding has begun "popping up" in various IRTF, IETF, and other forums
  - Heavily applied in RMT Working group specifications for end-to-end reliable multicast with ALC and NORM protocols
  - These protocols have also been effectively applied to some non-multicast use cases
    - FecFrame WG defined some additional "building blocks" beyond RMT products
- More general applicability and opportunity seen with new paradigms such as Information Centric Networking and Software Defined Networking

Architectural Considerations

- Aspects of packet network systems
  - Control plane
  - Routing / forwarding plane
  - Transport
  - Physical layer
- How can network coding be effectively and pragmatically applied to a scalable, distributed network like the Internet?
  - Congestion control
  - End system vs. Intermediate System
  - Edge systems (e.g. wireless)
- Where does network coding provide benefit and where does it not?

More considerations

- End-to-end vs. hop-by-hop
  - Intermediate system forwarding more stateful and complex than existing typical forwarding paradigms
- Intra-flow and inter-flow
- Application-layer use
- Service paradigms
  - "Best Effort" delivery can become tunable
  - Content dissemination
  - Multimedia and other streaming

Possible new service paradigms

- "Best effort" can become tunable
- Content dissemination
- Multimedia streaming
- "Data swarming"

Security

- Likely several challenges here
- How to sign content that is re-encoded?
- Intermediate system participation

Areas for standardization

- Common encoding algorithms
- Protocols:
  - Network Coding Transport
  - Routing: subgraph construction
  - Forwarding on subgraphs
- Service descriptions
- Packet formats

Candidate 2013 Activities

- Develop NWCRG charter
- Contributions to NWCRG Wiki site to build a repository of shared information
  - Research results and open problems
  - Architectures, algorithms, protocols, software
- Network coding taxonomy
  - Consensus on key terminology and concepts
  - I.e., establish a language for IRTF interaction

IRTF IPR Policy

- The IRTF follows the IETF Intellectual Property Rights (IPR) disclosure rules. This is a summary of these rules as they relate to IRTF research group discussions, mailing lists and Internet Drafts:

  - If you include your own or your employer's IPR in a contribution to an IRTF research group, then you must file an IPR disclosure with the IETF.

  - If you recognize your own or your employer's IPR in someone else's contribution and you are participating in the discussions in the research group relating to that contribution, then you must file an IPR disclosure with the IETF. Even if you are not participating in the discussion, the IRTF still requests that you file an IPR disclosure with the IETF.

  - Finally, the IRTF requests that you file an IPR disclosure with the IETF if you recognize IPR owned by others in any IRTF contribution.

  - The IRTF expects that you file IPR disclosures in a timely manner, i.e., in a period measured in days or weeks, not months. The IRTF prefers that the most liberal licensing terms possible are available for IRTF Stream documents, see RFC 5743. You may file an IPR disclosure here: http://www.ietf.org/ipr/file-disclosure

- See RFC 3979 (BCP 79) for definitions of "IPR" and "contribution" and for the detailed rules (substituting "IRTF" for "IETF").

IETF IPR Note Well

- Any submission to the IETF intended by the Contributor for publication as all or part of an IETF Internet-Draft or RFC and any statement made within the context of an IETF activity is considered an "IETF Contribution". Such statements include oral statements in IETF sessions, as well as written and electronic communications made at any time or place, which are addressed to:
  - – the IETF plenary session,
  - – any IETF working group or portion thereof,
  - – the IESG or any member thereof on behalf of the IESG,
  - – the IAB or any member thereof on behalf of the IAB,
  - – any IETF mailing list, including the IETF list itself,
  - – any working group or design team list, or any other list
  - – functioning under IETF auspices,
  - – the RFC Editor or the Internet-Drafts function
- All IETF Contributions are subject to the rules of RFC 3978 (updated by RFC 4748) and RFC 3979(updated by RFC 4879). Statements made outside of an IETF session, mailing list or other function, that are clearly not intended to be input to an IETF activity, group or function, are not IETF Contributions in the context of this notice. Please consult RFC 3978 (and RFC 4748) for details. A participant in any IETF activity is deemed to accept all IETF rules of process, as documented in Best Current Practices RFCs and IESG Statements. A participant in any IETF activity acknowledges that written, audio and video records of meetings may be made and may be available to the public.