

Getting and Exchanging Decoding State Information

Cédric Adjih (Inria), Oumaima Attia (Inria)
Ichrak Amdouni (ENISO)

IETF/IRTF 106 - NWCRG

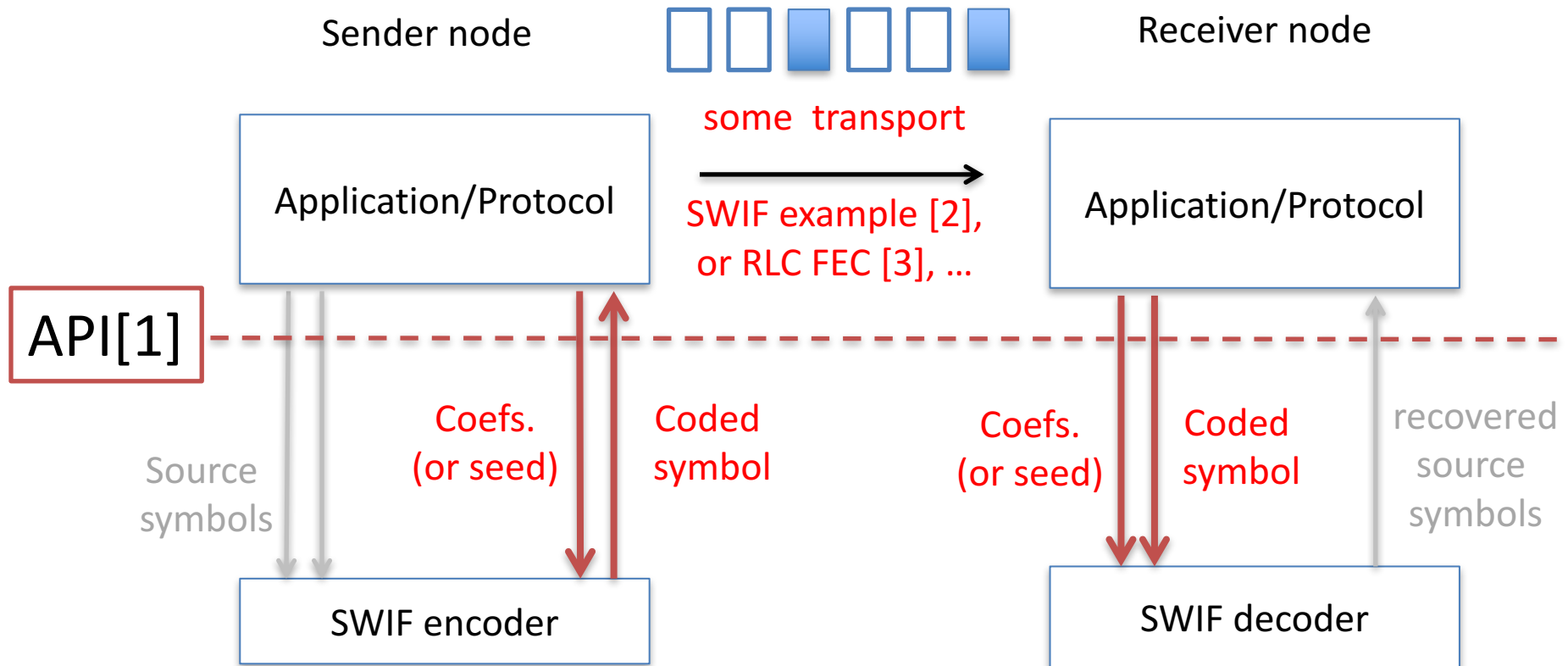
Nov 2019, Singapore

Motivation

- Practical problem (low level):
 - Challenging the codec API draft in [1]: complete?
- General problem (high level):
 - Need for state exchange for protocols
- Questions:
 - Extend API (and implementation)?
 - Interest? Feedback? Ideas?

[1] <https://datatracker.ietf.org/doc/draft-roca-nwcr-g-generic-fec-api/>

Example of SWIF (RLC) codec (API)



[1] <https://datatracker.ietf.org/doc/draft-roca-nwcr-g-generic-fec-api/>

[2] SWIF codec implementation, Open-source sliding window FEC codec , <https://github.com/irtf-nwcr/swif-codec>

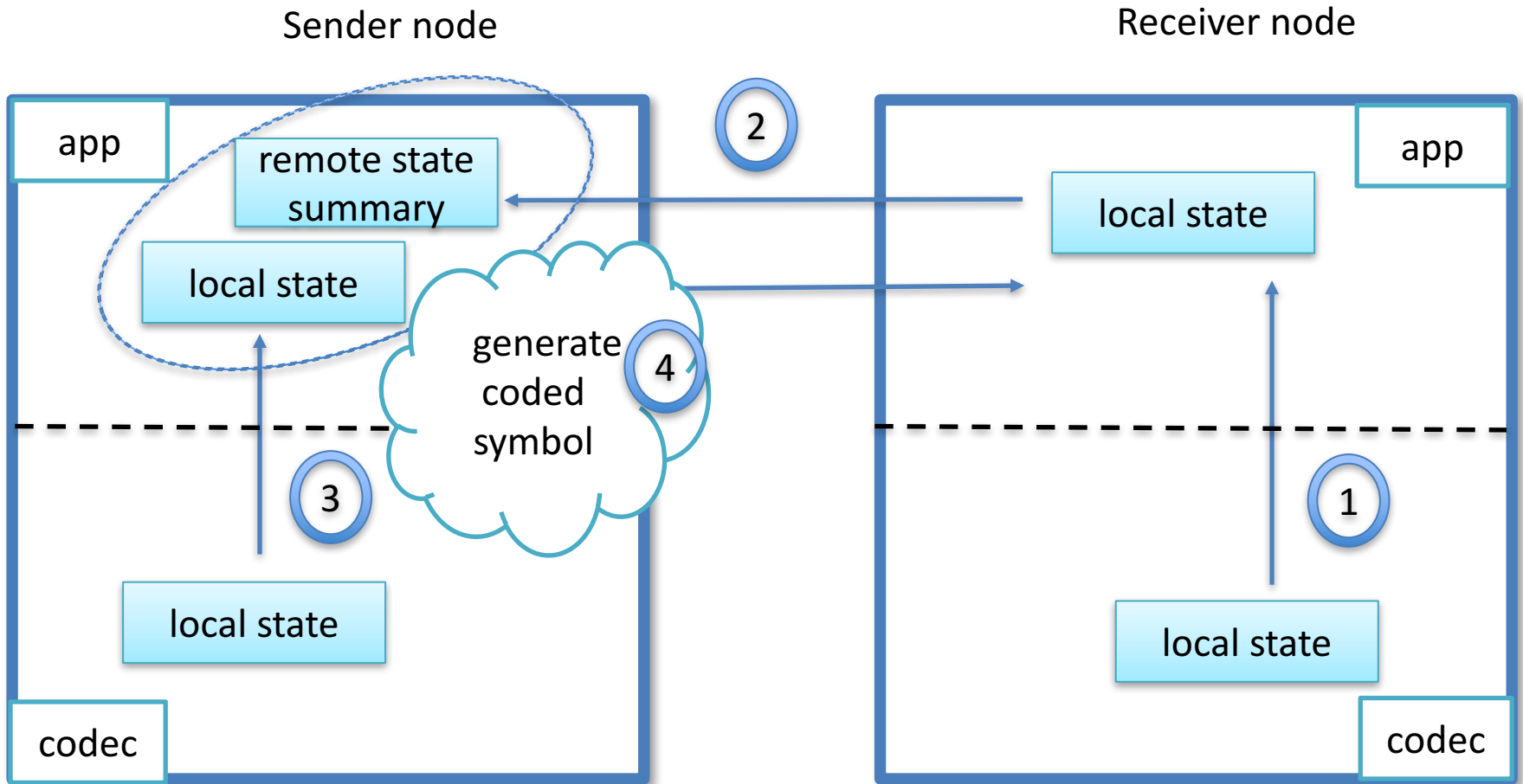
[3] <https://datatracker.ietf.org/doc/draft-ietf-tsvwg-rlc-fec-scheme/>

Challenging the API?

- E.g. support:
 - Feedback,
 - Information Centric Networking, ICN (e.g. [1])
 - Random linear network coding, RLNC - recoding,
 - Multicast (transport, or fragments FEC with acks.)
- Existing protocols: not always codec abstraction

[1] K. Matsuzono, H. Asaeda, C. Westphal <https://datatracker.ietf.org/doc/draft-irtf-nwcrg-nwc-ccn-reqs/>

What information is needed?



Challenge the API?

- Not so straightforward cases:
 - Information Centric Networking
 - Random Linear Network Coding
- Focus on encoder:
 - **Select indices in coded symbol and to generate coded symbol:**
 - What do my peers need?
 - E.g. what are their **requirements?** Based on **decoder state**
 - What coded symbols can I generate?
 - E.g. what is my **decoder state?**
 - Match both
- Information need to be useful
 - E.g. matrices of neighbors → index coding problem
- Where should the choice be made?
 - Choice(?): **decision at application/protocol (above codec)**

Local (decoding) state

- Decoder state as matrix:

- Complete but large(?)
- Algebra in application?
- Alternate? (Tanner?)

$$\begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 9 & 10 & 12 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 2 & 13 & 0 & 14 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 13 & 7 & 0 & 3 & 5 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 15 & 0 & 3 & 5 & 12 \end{pmatrix}$$

$$\left\{ \begin{array}{l} P_3 = Q_1 \\ P_4 = Q_2 \\ P_7 = Q_3 \\ 9P_5 + 10P_6 + 12P_7 + P_9 = Q_4 \\ P_5 + 2P_6 + 13P_7 + 14P_9 = Q_5 \\ 13P_6 + 7P_7 + 3P_9 + 5P_{10} = Q_6 \\ 15P_7 + 3P_9 + 5P_{10} + 12P_{11} = Q_7 \end{array} \right.$$

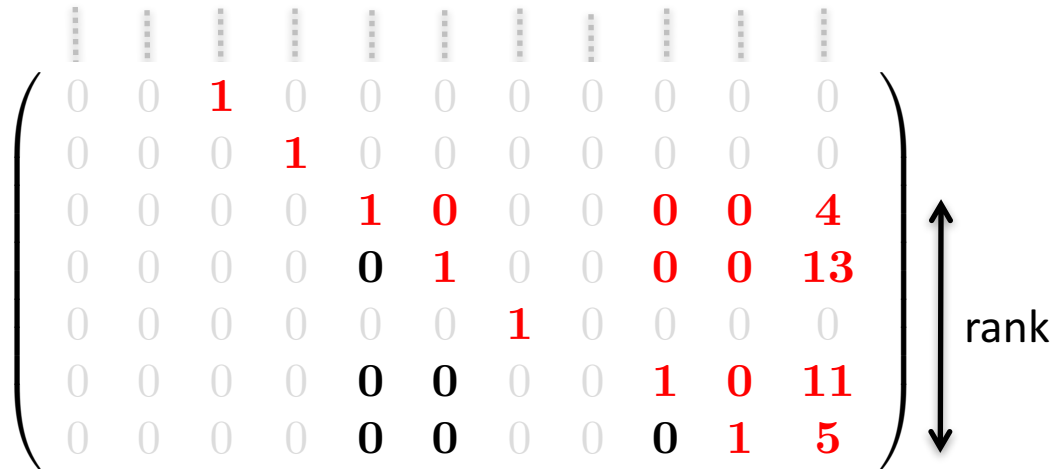
$$\begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 4 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 13 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 11 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 5 \end{pmatrix}$$

→ Question: good representation for the local state, other than matrix?

Remote state & Summary

- State or request
- Implicit state
- Explicit summary:

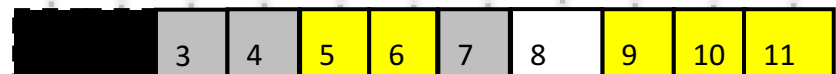
– Matrix



– Coarse view: first removed, last decoded, rank, last seen



– Per column: unwanted, unseen uninteresting, interesting [1]



– Per column, pivots



- Per row, etc.

→ Question: good representation for the summary of remote state, other than matrix?

Applying to protocols?

- Examples of protocols

	State	Summary
Network Coding for CCN/NDN[1]		“Feedback”, “extensions in the TLV header of the Interest”
Dragoncast-2008 [2] DragonNet [3]		Last symbol decoded, (fixed) window size (+rank, +highest symbol_id)
Tetrys [4]		Ack: symbol start, #missing symbols, ack. symbols bitmap, nb rows
CISEW [5]		Req: unwanted, unseen, uninteresting, interesting

[1] K. Matsuzono, H. Asaeda, C. Westphal <https://datatracker.ietf.org/doc/draft-irtf-nwcr-g-nwc-ccn-reqs/>

[2] S-Y. Cho and C. Adjih, "Wireless Broadcast with Network Coding: DRAGONCAST", Inria RR-6569, July 2008; and S-Y. Cho' PhD Thesis (2008) and <https://www.ietf.org/archive/id/draft-adjih-dragoncast-00.txt>

[3] I. Amdouni, A. Masucci, H. Baccouch, C. Adjih "DragonNet: Specification, Implementation, Experimentation and Performance Evaluation", report, 2014, <https://hal.inria.fr/hal-01632790v1>

[4] J. Detchart, E. Lochin, J. Lacan, V. Roca - Tetrys draft <https://datatracker.ietf.org/doc/draft-detchart-nwcr-g-tetrys/>

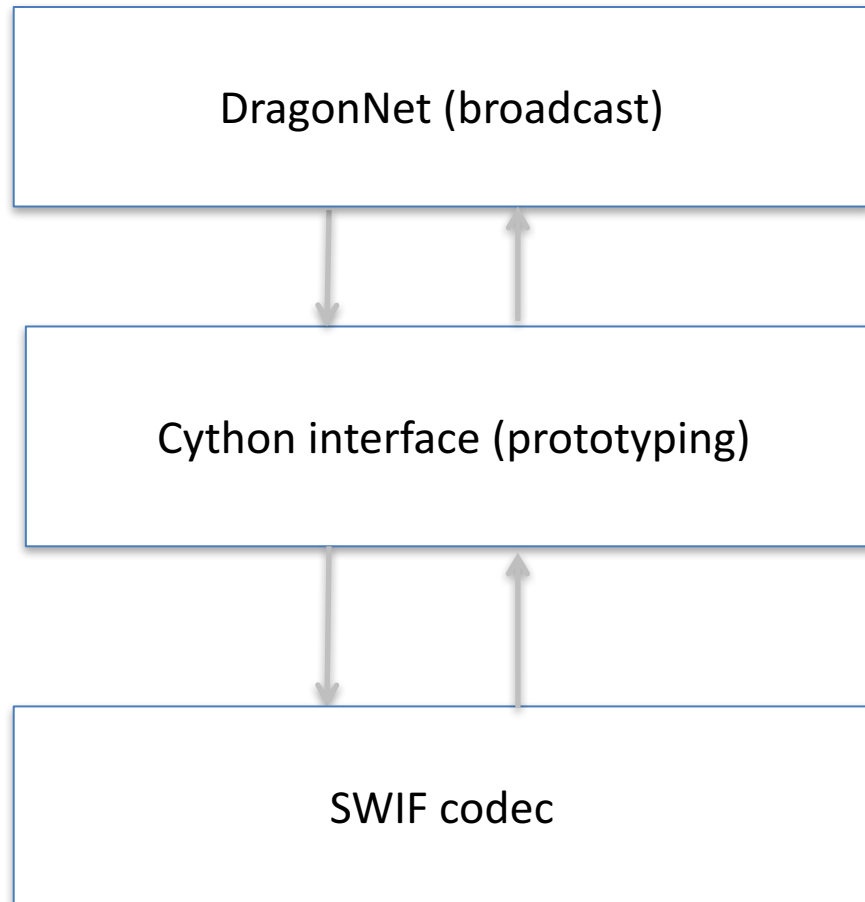
[5] I. Amdouni, C. Adjih <https://tools.ietf.org/id/draft-amdouni-nwcr-g-cisew-00.txt>

To go further

- Maybe: start from a practical case (NC implementation)
 1. Fitting it to the API in the draft
 - (+) First trial to be compliant with the API
 2. Suggestions to adapt the API accordingly
 - (+) no better than the integration with an implementation to complete the API
 3. Need to work on the getting and exchanging questions cited above for specific scenario (or not?)
 - E.g., DragonNet [1]
- More general cases of state exchanges in protocol?
- Advice, comments, contributions, discussions?

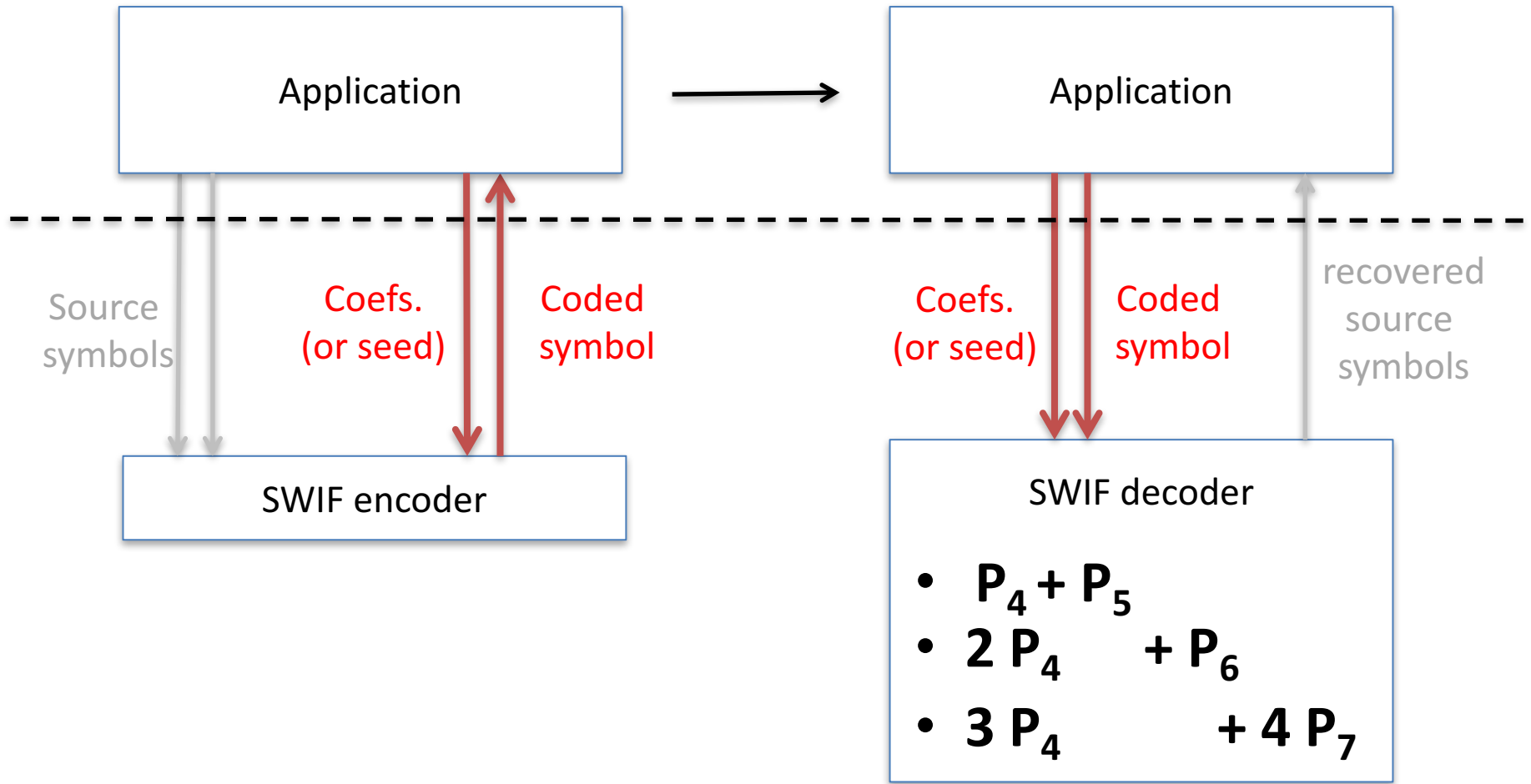
[1] DragonNet implementation, <https://gitlab.inria.fr/GardiNet/dragonnet>

Work in progress



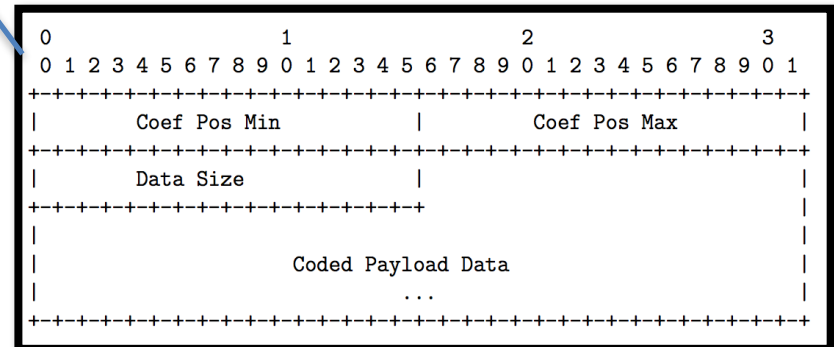
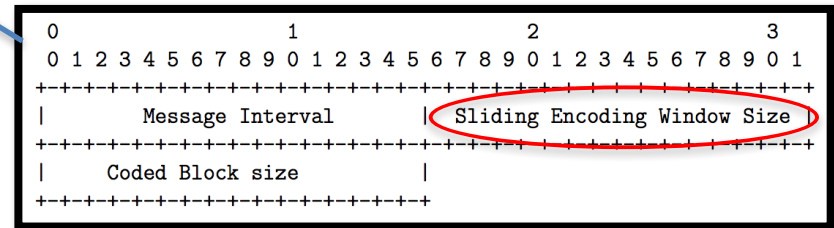
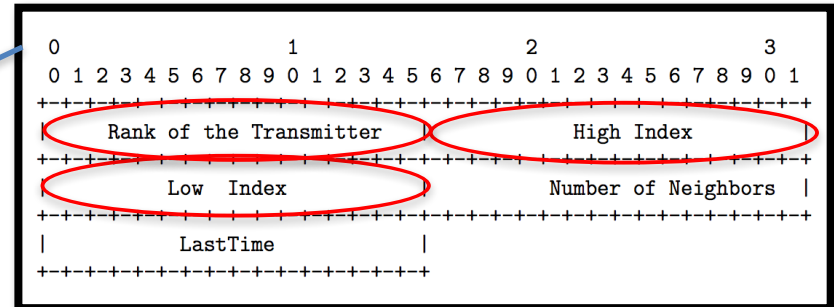
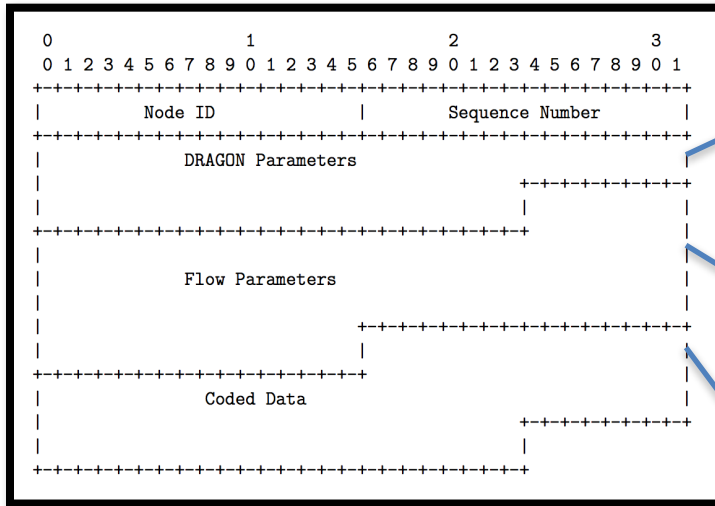
[1] DragonNet, <https://gitlab.inria.fr/GardiNet/dragonnet>

Example of SWIF (RLC) codec (API)



[1] <https://datatracker.ietf.org/doc/draft-roca-nwcr-g-generic-fec-api/>

Dragoncast 2008/DragonNet (2014)



$$\begin{pmatrix}
 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 11 & 1 & 0 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
 0 & 0 & 0 & 0 & 5 & 0 & 0 & 0 & 1 & 0 & 0 \\
 0 & 0 & 0 & 0 & 9 & 0 & 0 & 0 & 0 & 1 & 0 \\
 0 & 0 & 0 & 0 & 8 & 0 & 0 & 0 & 0 & 0 & 1
 \end{pmatrix}$$

- [1] S-Y. Cho and C. Adjih, "Wireless Broadcast with Network Coding: DRAGONCAST", Inria RR-6569, July 2008; and S-Y. Cho' PhD Thesis (2008)
- [2] <https://www.ietf.org/archive/id/draft-adjih-dragoncast-00.txt>
- [3] I. Amdouni, A.Masucci, H. Baccouch, C. Adjih "DragonNet: Specification, Implementation, Experimentation and Performance Evaluation", report, 2014, <https://hal.inria.fr/hal-01632790v1>

CISEW

- Coding Interval-based Sliding Encoding Window:
I.Amdouni, C. Adjih, "Coding Interval-based Sliding Encoding Window", draft-amdouni-nwcr-g-cisew-00 (work in progress), July 2014, <http://tools.ietf.org/html/draft-amdouni-nwcr-g-cisew-00>
- Redesign of SEW allowing "desynchronization" (real-time)
 - Assume limited decoding buffer:
 - Choice between throwing decoded or undecoded packets
 - Combinations may become useless: $P_{11}+...$ if P_{11} dropped
- Need for a more general buffer management,
- Need for a more general encoding strategy, and:
- Need for more information about the state of neighbors
 - Updated signaling: unwanted, uninteresting, interesting, unseen



- Discussion (& heuristics) in the draft, several tradeoffs