Getting and Exchanging Decoding State Information

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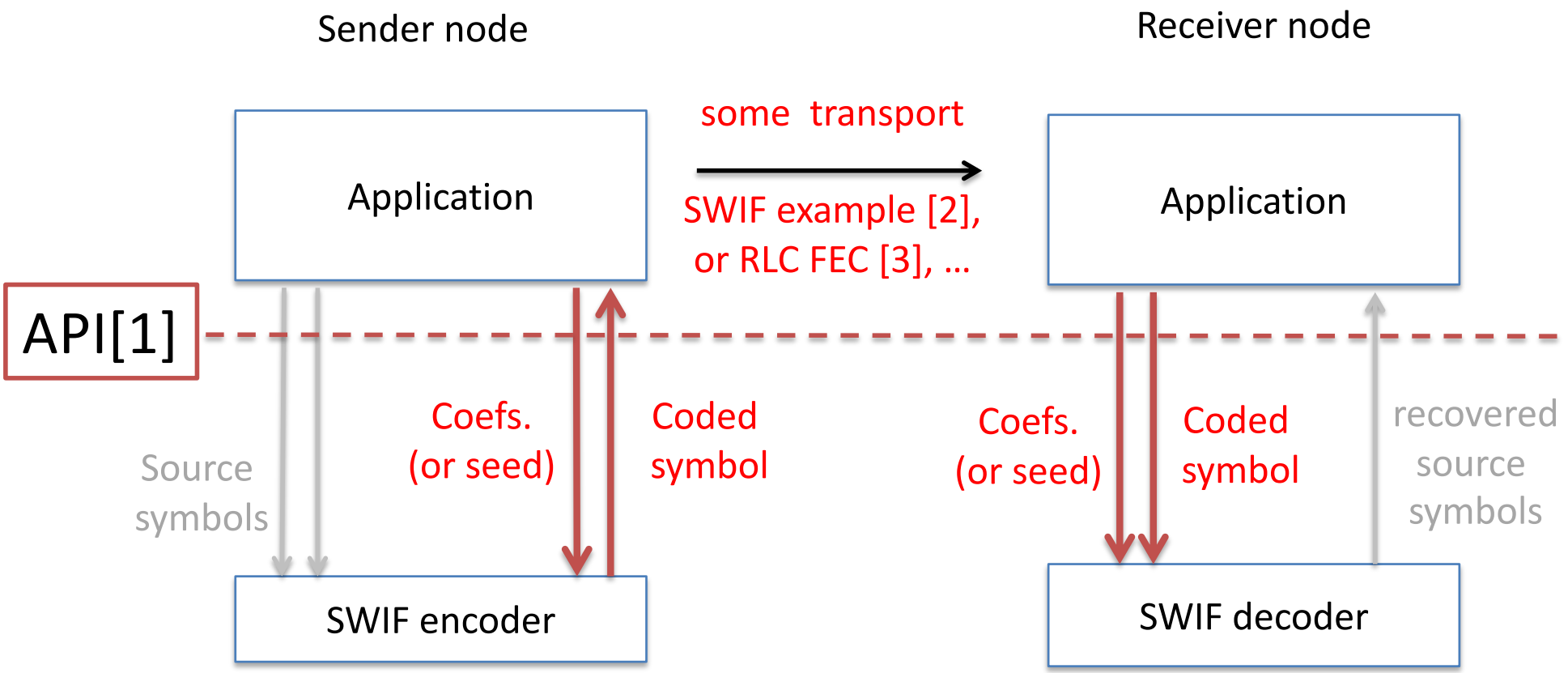
Motivation

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

[1] https://datatracker.ietf.org/doc/draft-roca-nwcrg-generic-fec-api/

Example of SWIF (RLC) codec (API)



[1] https://datatracker.ietf.org/doc/draft-roca-nwcrg-generic-fec-api/

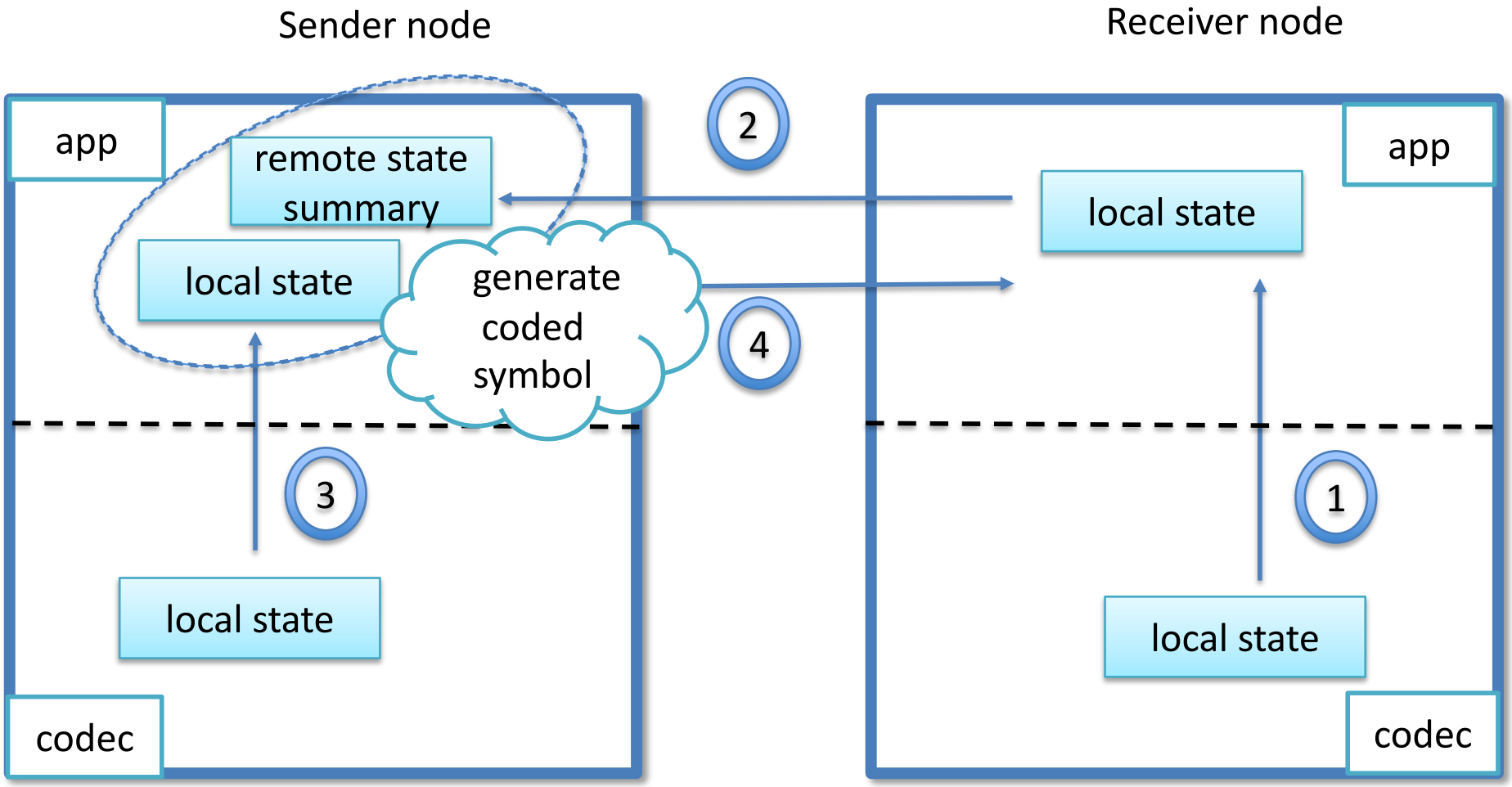
[2] SWIF codec implementation, an Open-source sliding window FEC codec https://github.com/irtf-nwcrg/swif-codec

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

Generalizing the API?

- E.g. support: feedback, random linear network coding, recoding, ICN, broadcast,…
- Need to decide on the indices in coded symbols
  - For API and in general,
    - Good choice(?): decision at application
  - What coded symbols can I generate?
    - E.g. what is my decoding state?
  - What do my peers need?
    - E.g. what are their requirements? Based on decoding state
  - Match both

What information is needed?



Local state

- Decoder state as matrix:
  - Complete but large(?)
  - Algebra in application?
  - Alternate? (Tanner?)

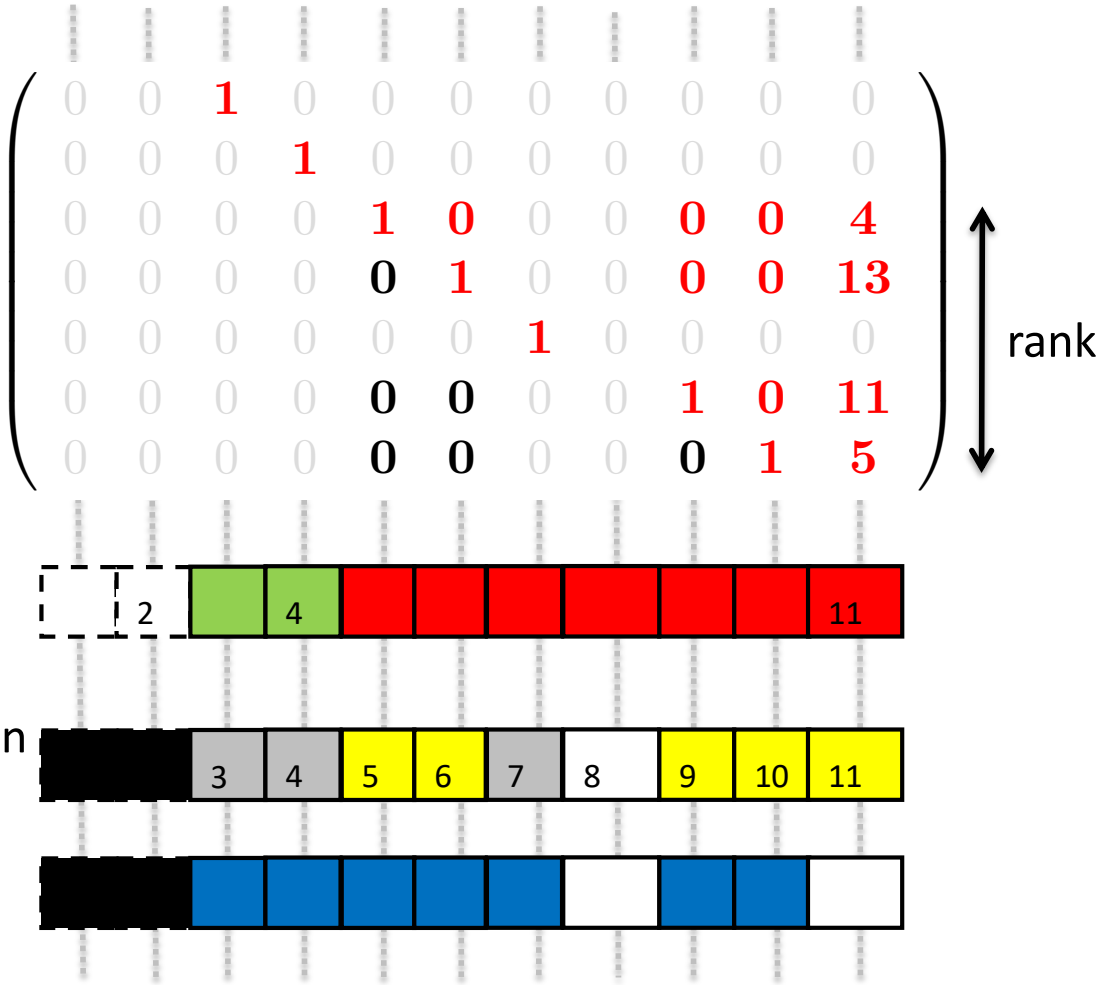
$$\begin{pmatrix} 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \mathbf{1} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \mathbf{9} & \mathbf{10} & \mathbf{12} & \mathbf{0} & \mathbf{1} & 0 & 0 \\ 0 & 0 & 0 & 0 & \mathbf{1} &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

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

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

Remote state & Summary

- State or request
- State summary:
  - Matrix
  - Implicit (acks,…)
    - Coarse view: first removed, last decoded, rank, last seen
    - Per column: unwanted, unseen uninteresting, interesting
    - Per column, pivots
    - Per row, etc.



What information is needed?

- Information need to be useful
  - E.g. matrices of neighbors -> index coding pb.

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

[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) and https://www.ietf.org/archive/id/draft-adjih-dragoncast-00.txt

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

[3] J. Detchart, E. Lochin, J. Lacan, V. Roca - Tetrys draft https://datatracker.ietf.org/doc/draft-detchart-nwcrg-tetrys/

[4] K. Matsuzono, H. Asaeda, C. Westphal https://datatracker.ietf.org/doc/draft-matsuzono-nwcrg-nwc-ccn-reqs/

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

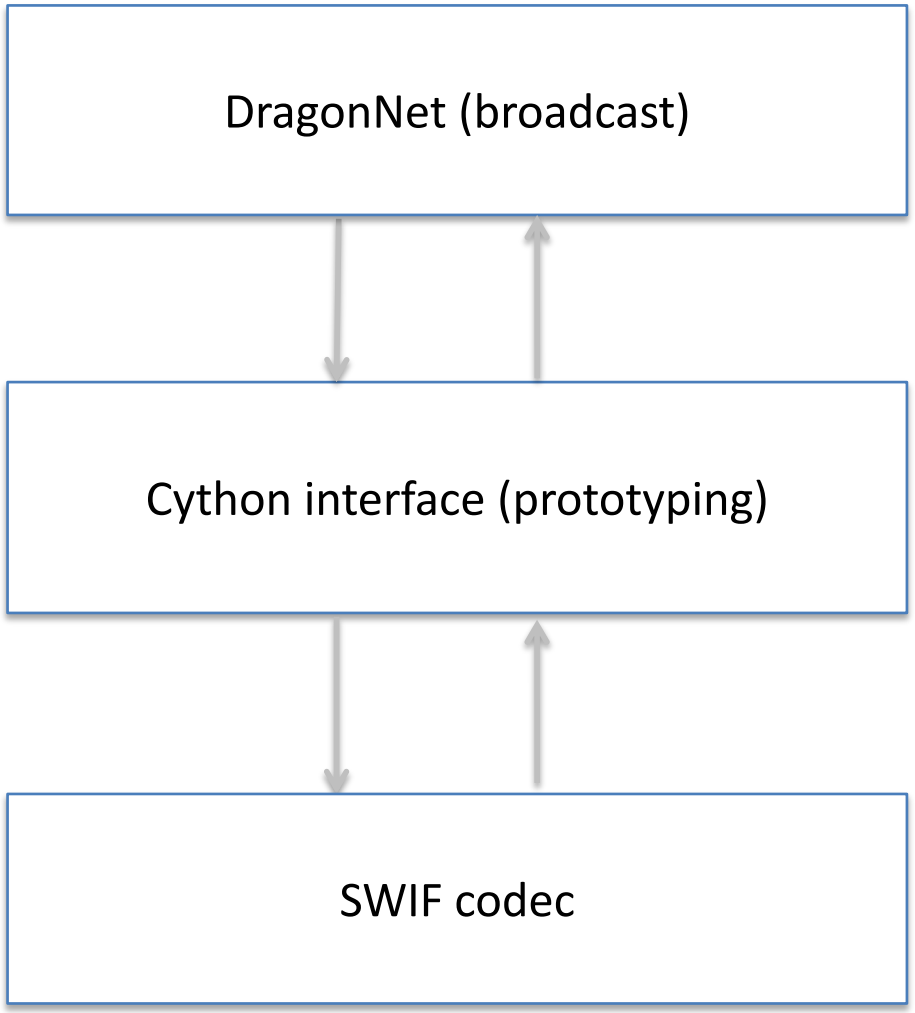
To go further

- 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. Adapting the API accordingly
     - (+) no better than the integration with an implemetation to complete the API
  3. Need to work on the getting and exchanging questions cited above for specific scenario (or not?)

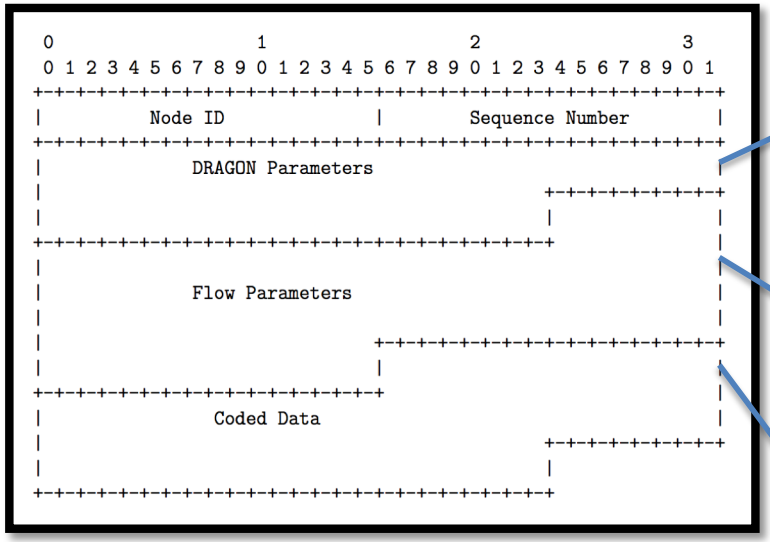
  – E.g., DragonNet [1]
- Contributions, advice, comments, discussions?

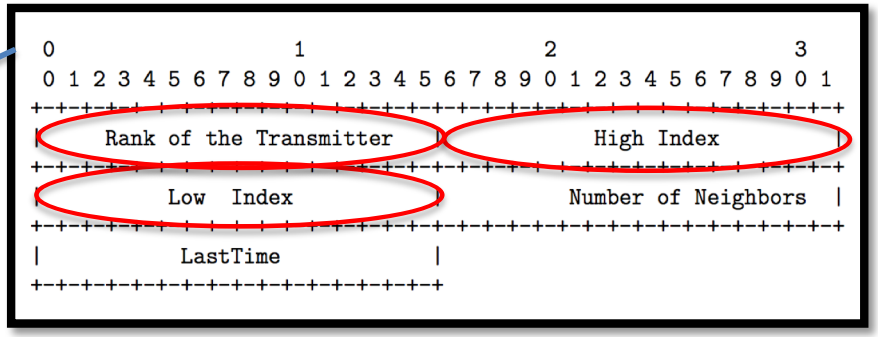
[1] DragonNet, https://gitlab.inria.fr/GardiNet/dragonnet

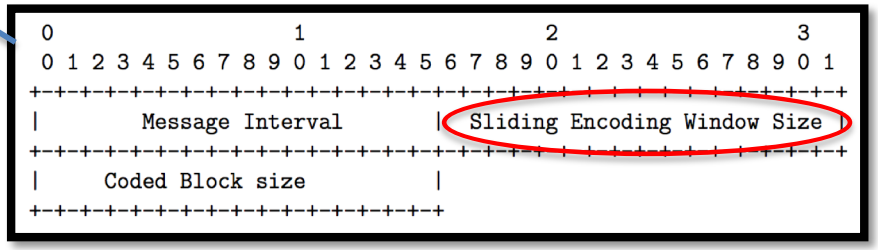
Work in progress

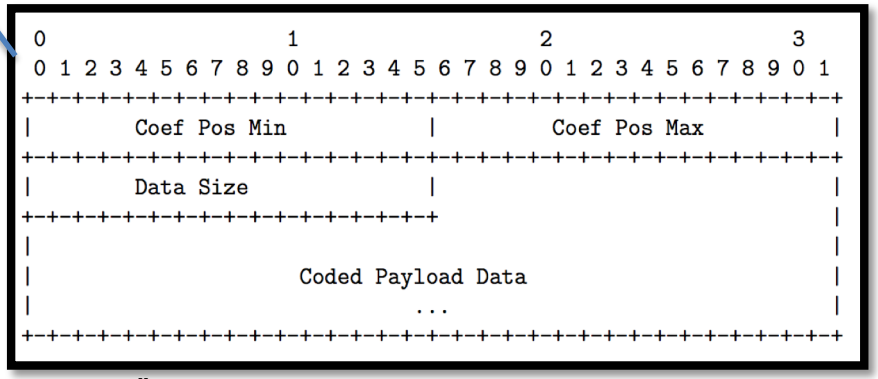


Dragoncast 2008/DragonNet (2014)







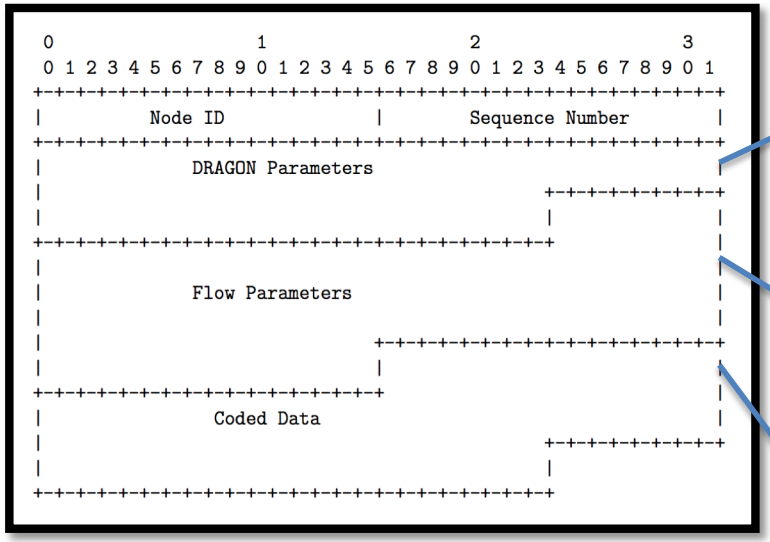


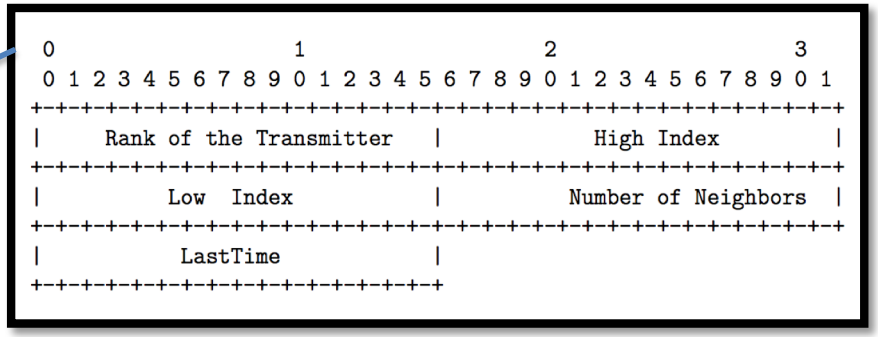
$$\begin{pmatrix} 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 11 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 5 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 9 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 &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

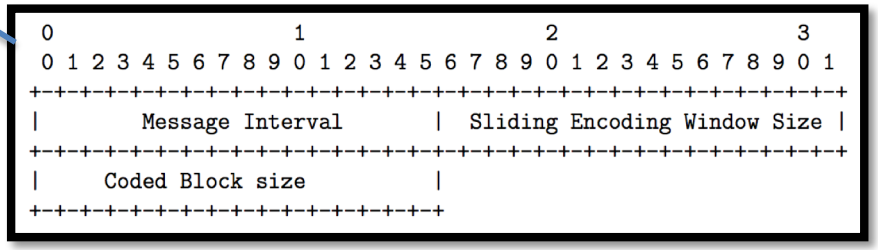
[1] S-Y. Cho and C. Adjih, "Wireless Broadcast with Network Coding: DRAGONCAST", Inria RR-6569, July 2008; and S-Y. Cho' PhD Thesis (2008)

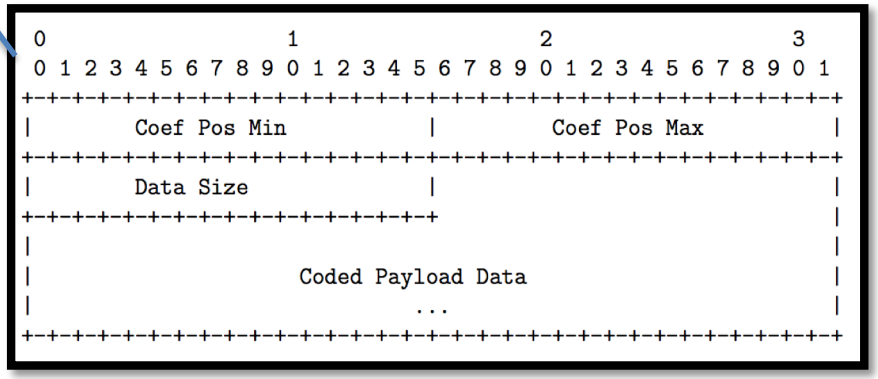
[2] https://www.ietf.org/archive/id/draft-adjih-dragoncast-00.txt

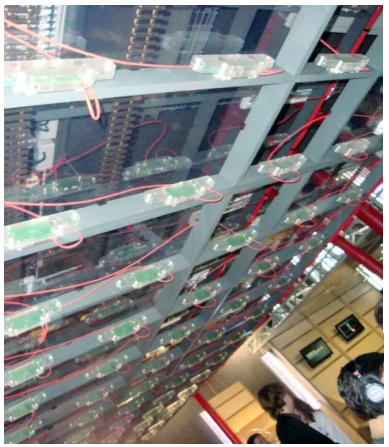
[3] I. Amdouni, A.Masucci, H. Baccouch, C. Adjih "DragonNet: Specification, Implementation, Experimentation and Performance Evaluation", report, 2014, https://hal.inria.fr/hal-01632790v1

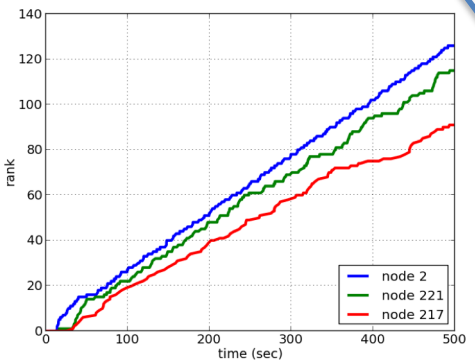

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Node ID
Sequence Number
DRAGON Parameters
Flow Parameters
Coded Data

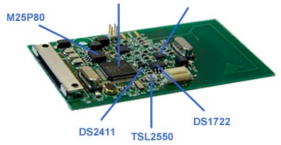

0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Rank of the Transmitter
High Index
Low Index
Number of Neighbors
LastTime


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Message Interval
Sliding Encoding Window Size
Coded Block size


0 1 2 3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
Coef Pos Min
Coef Pos Max
Data Size
Coded Payload Data
...




rank
time (sec)
node 2
node 221
node 217

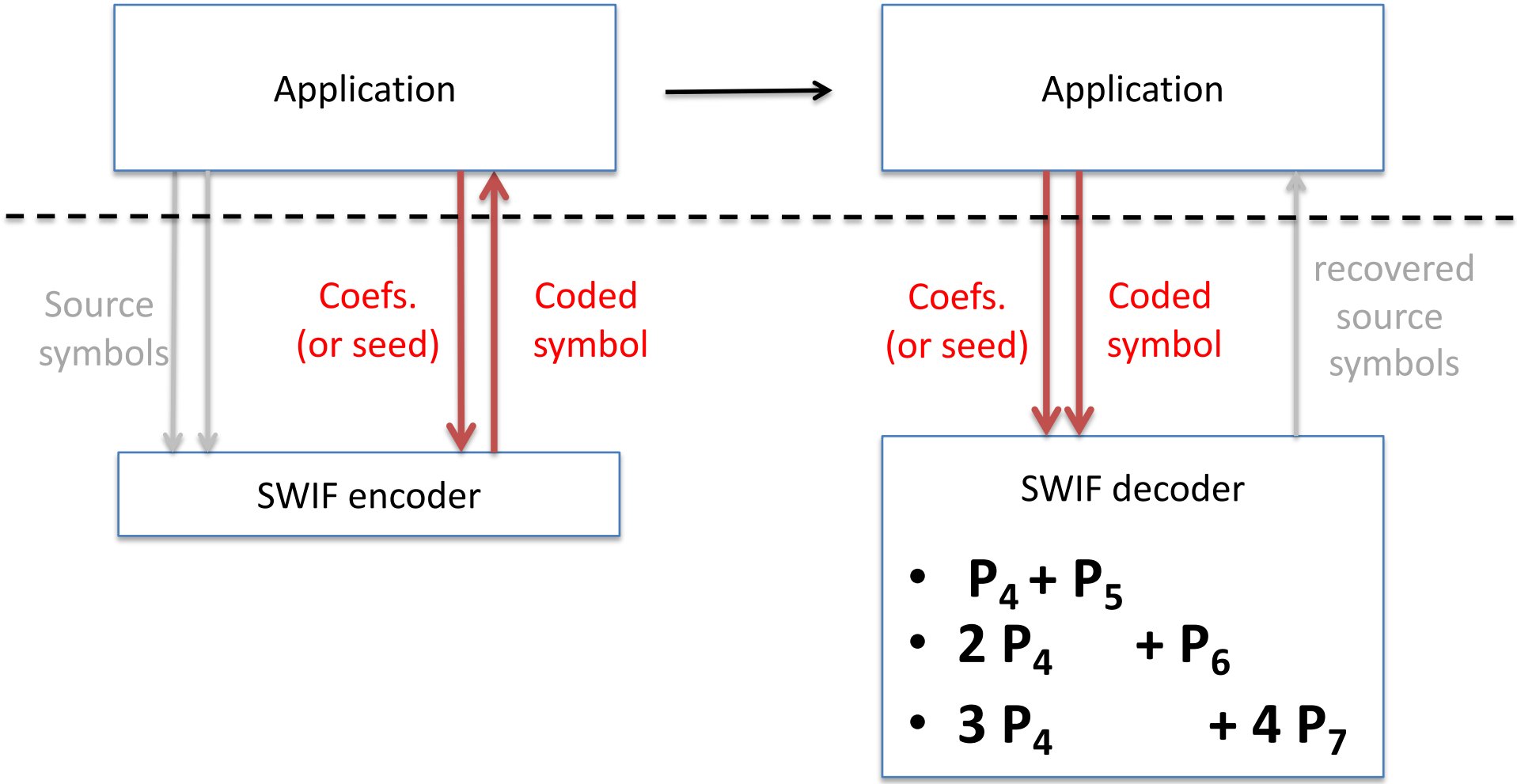

M25P80
DS2411
TSL2550
DS1722

Motivation/Goal

- Low level: Augmenting the API draft in [1]:
  - API currently does not explicitly target feedback
  - API does not explicitly include recoding, etc.
- High level: State exchange for protocol
  - Useful for sending “innovative” packets
  - Useful for broadcast (many neighbors)
  - Useful for Information Centric Networking (ICN)
- Motivation: more complete API? interest?

[1] https://datatracker.ietf.org/doc/draft-roca-nwcrg-generic-fec-api/

Example of SWIF (RLC) codec (API)



[1] https://datatracker.ietf.org/doc/draft-roca-nwcrg-generic-fec-api/

CISEW

- Coding Interval-based Sliding Encoding Window:

  I.Amdouni, C. Adjih, "Coding Interval-based Sliding Encoding Window", draft-amdouni-nwcrg-cisew-00 (work in progress), July 2014, http://tools.ietf.org/html/draft-amdouni-nwcrg-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

Sliding “Encoding” Window (SEW)

- Reversed RREF:
- $Q_1 = P_4 + P_5$
- $Q_2 = P_4 + P_6$
- $Q_3 = P_4 + 4P_7$

- RREF:
- $Q'_1 = P_4 + P_5$
- $Q'_2 = P_5 - 4P_7$
- $Q'_3 = -P_6 + 4P_7$