Tetrys, a Patent Free, On-the-fly Network Coding Protocol

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Note Well

- We, the authors, didn't try to patent any of the material included in this presentation
- We, the authors, are not reasonably aware of patents on the subject that may be applied for by our employers
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http://irtf.org/ipr

Motivations and Goals

- At IETF 86 we introduced Tetrys, an on-the-fly Network Coding Protocol

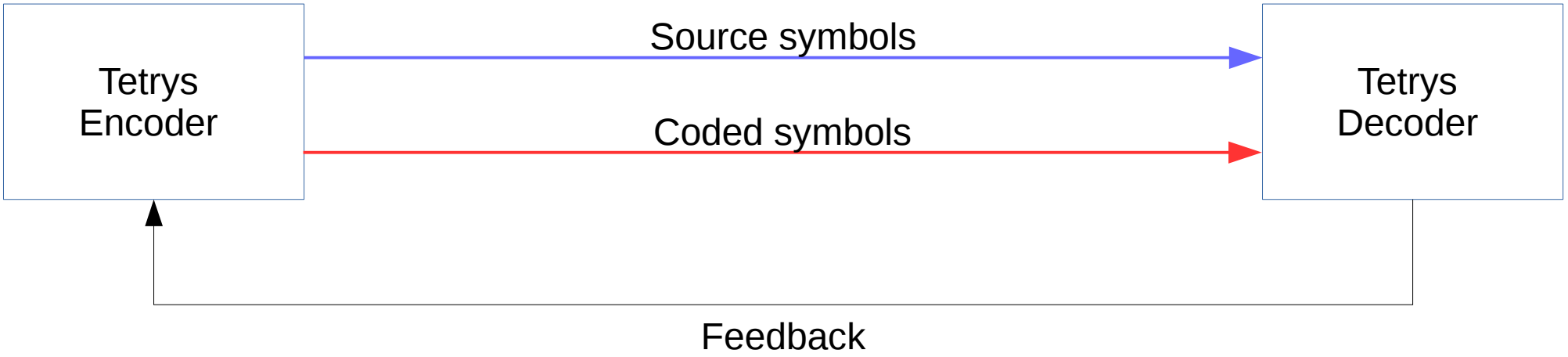
  http://www.ietf.org/proceedings/86/slides/slides-86-nwcrg-1.pdf

- Some implementations of network coding already exist, some of them patented.
- We believe there is a need for a (presumed) patent free standard protocol for network coding

Use Cases

- Unicast/Multicast
  - Coded symbols are linear combinations of all source symbols **non-acknowledged** by all the receivers
- Multi Source
  - The coded symbols can be received from several individual sources

An End-to-end Approach



- Using a systematic code, the source symbols are sent in addition to coded symbols

Encoding

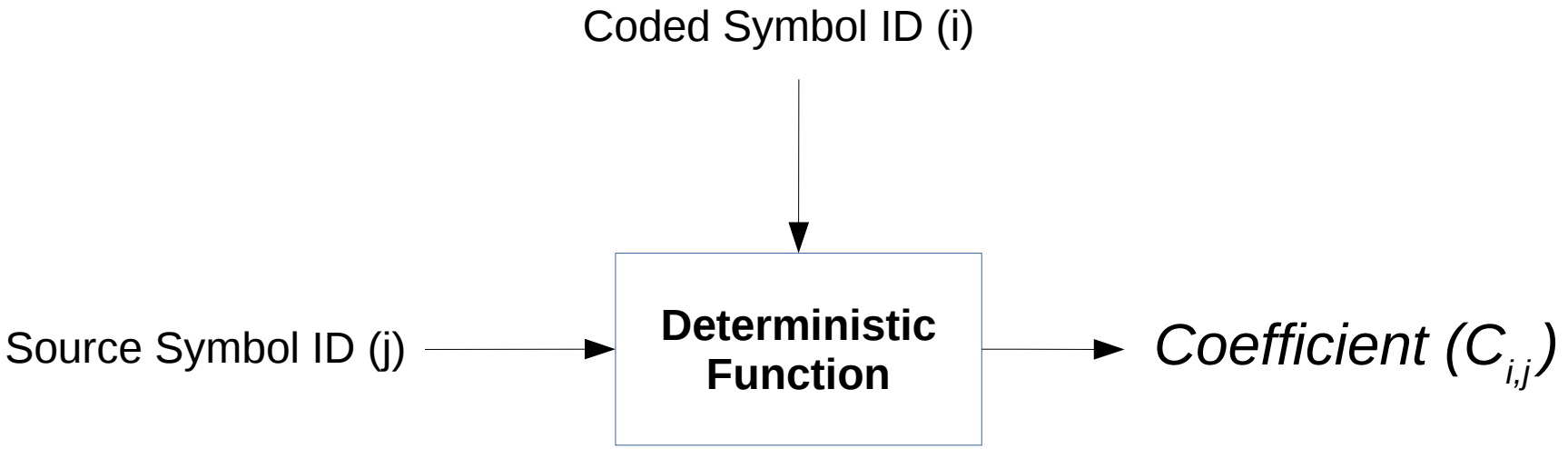
- A coded symbol is a linear combination of source symbols in the elastic encoding window : each source symbol is multiplied by a coefficient, and the result is the sum of the products

$$R^{l}_{i..j} = \sum_{u=i}^{j} C_{l,u} * S_u$$

- Question : how do we choose the coefficients ?

Choosing the Coefficients

- Each coding coefficient is chosen by using a deterministic function taking as input the coded symbol ID and the current source symbol ID
  - The deterministic function must be known by the encoder and the decoder (i.e. it is specified in the standard)



The Encoding Vectors

- They allow the encoder to send information about linear combinations done in the coded symbols
  - They contain the source symbol IDs
- An encoded vector is included in a Coded Packet (encoding vector and coded symbol)

  - NB : an encoding vector may contain the list of the coefficients used for each source symbol ID as well

The Decoding Process

- The decoding algorithm is as follows:
  - For each coded symbol, generate the coefficients for all the associated source symbols
  - Subtract the known source symbols from the coded symbols
  - Do a matrix inversion to rebuild the missing source symbols:

$$\left(R_0, R_1, R_2, R_4\right) * \begin{pmatrix} C_{0,0} & C_{1,0} & C_{2,0} & C_{3,0} \\ C_{0,1} & C_{1,1} & C_{2,1} & C_{3,1} \\ C_{0,2} & C_{1,2} & C_{2,2} & C_{3,2} \\ C_{0,3} & C_{1,3} & C_{2,3} & C_{3,3} \end{pmatrix}^{-1} = \left(S_0, S_1, S_2, S_3\right)$$

The Feedback

- Useful to reduce the (en|de)coding complexity
  - Will allow the encoder to reduce the elastic encoding window by removing all the received/decoded source symbols
- They can be used to adapt the code rate
  - The Acknowledgement packets contain the number of missing source symbols and the number of available equations

Conclusions

- We propose Tetrys a patent free network coding protocol to foster innovation and generate novel deployment approaches
- The proposed protocol works in unicast and multicast use-cases and can also be multi source
  - other use cases are also under investigation, notably recoding
- Comments are welcome !

Thank you !

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Draft:
http://tools.ietf.org/html/draft-detchart-nwcrg-tetrys-00

Just a Reminder...