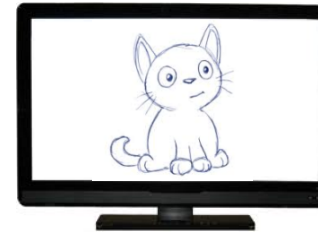
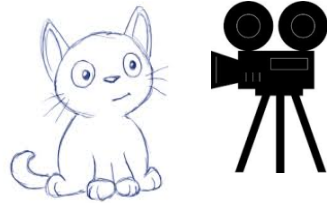


***NC for new members -
Existing network codes and
protocols***

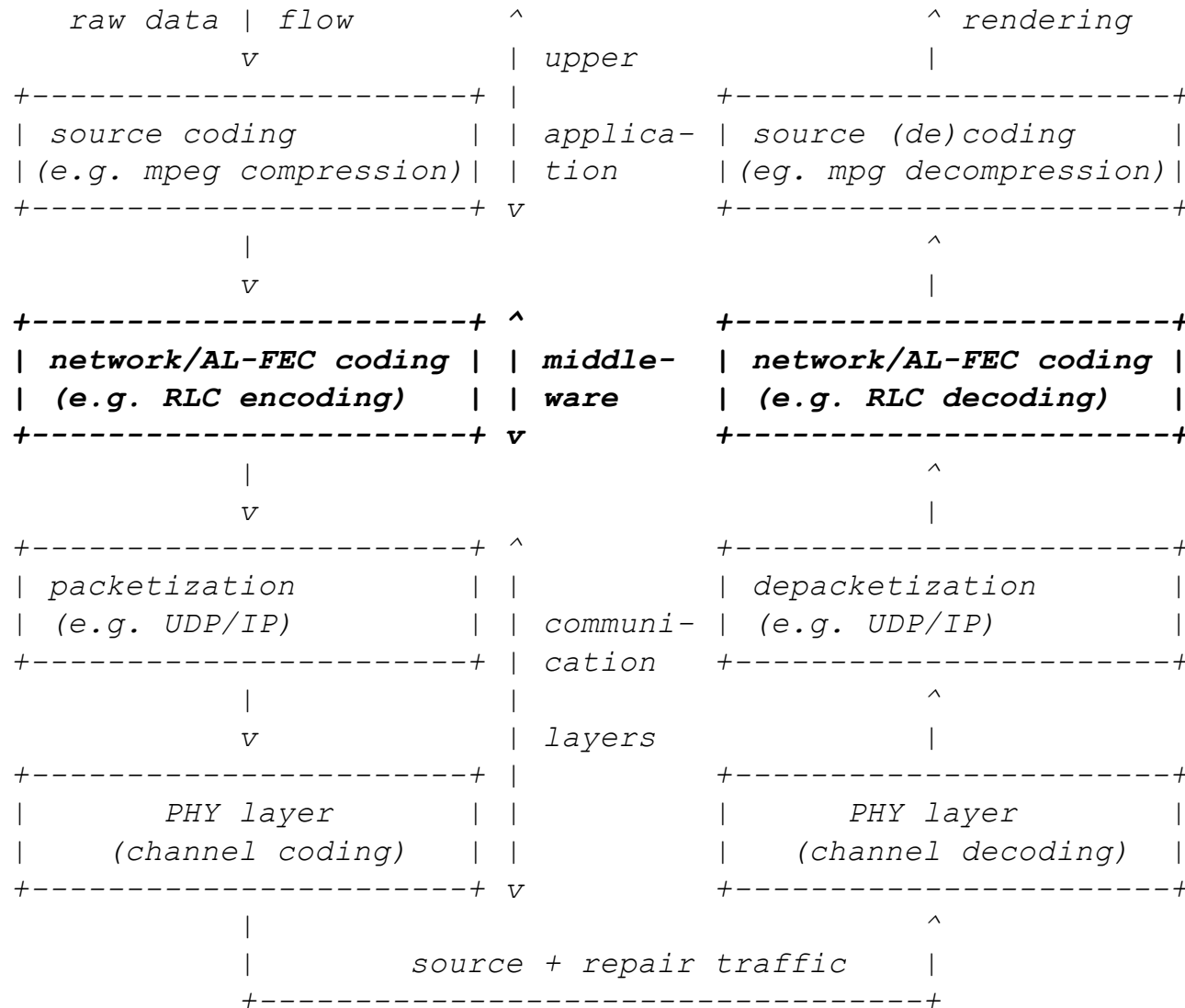
Marie-José Montpetit, Vincent Roca

NWCRG, IETF100, Singapore

Source, network and channel/PHY coding

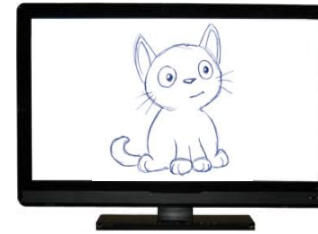


Ex. 1- network coding as a middleware

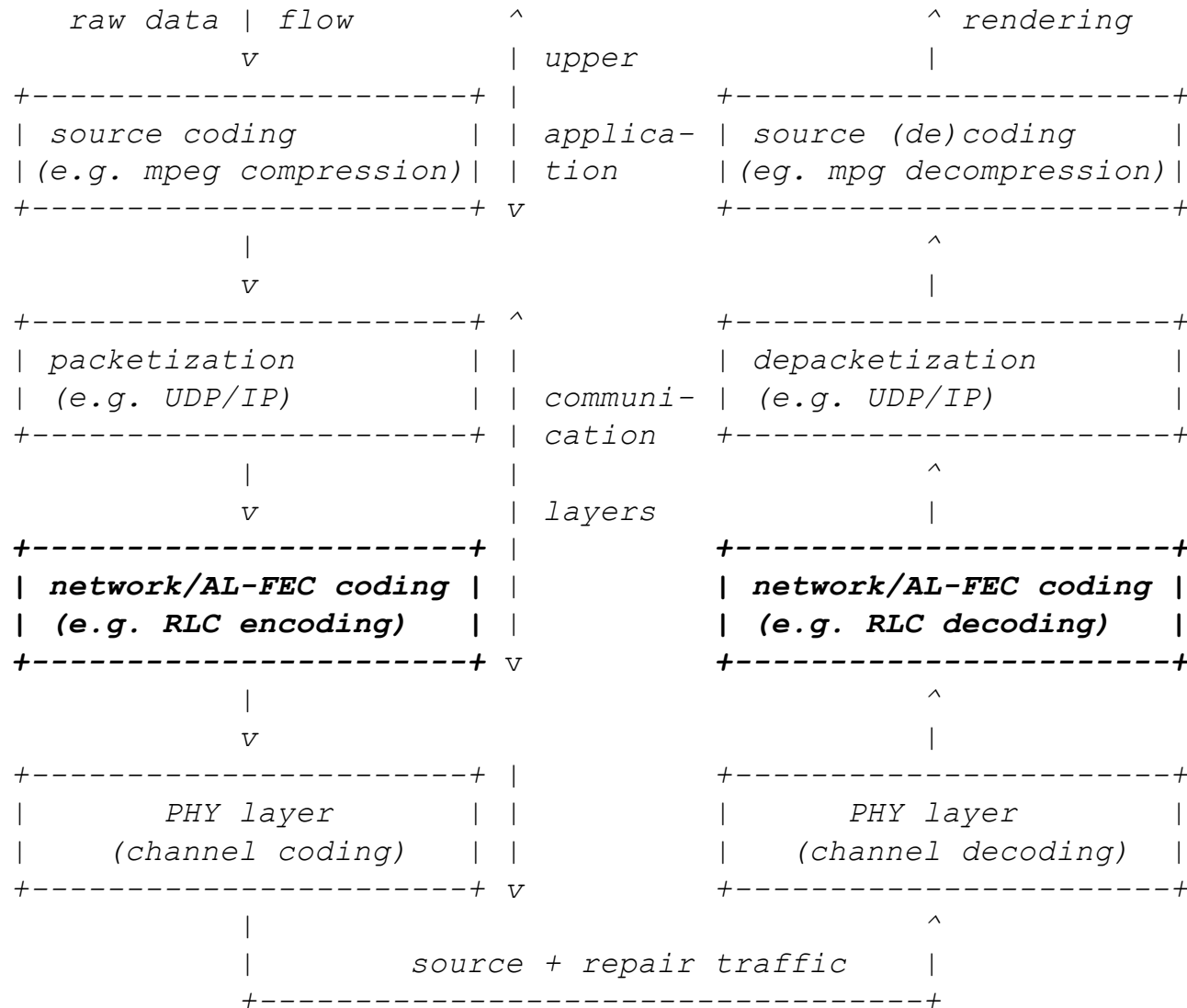


NWCRG
focus

Source, network and PHY coding (2)



Ex. 2- network coding in comm. layers



NWCRG focus

Basic assumptions

- **NWCRG does not consider:**

- PHY layer transmission issues
- PHY layer codes
- bit error detection/correction

out of scope

- **NWCRG deals with:**

- **all forms of packets**

- IP datagrams, UDP datagrams, UDP payloads, TCP segments, application data units, etc.
- depends on the way it's applied

- **packet losses (only)**

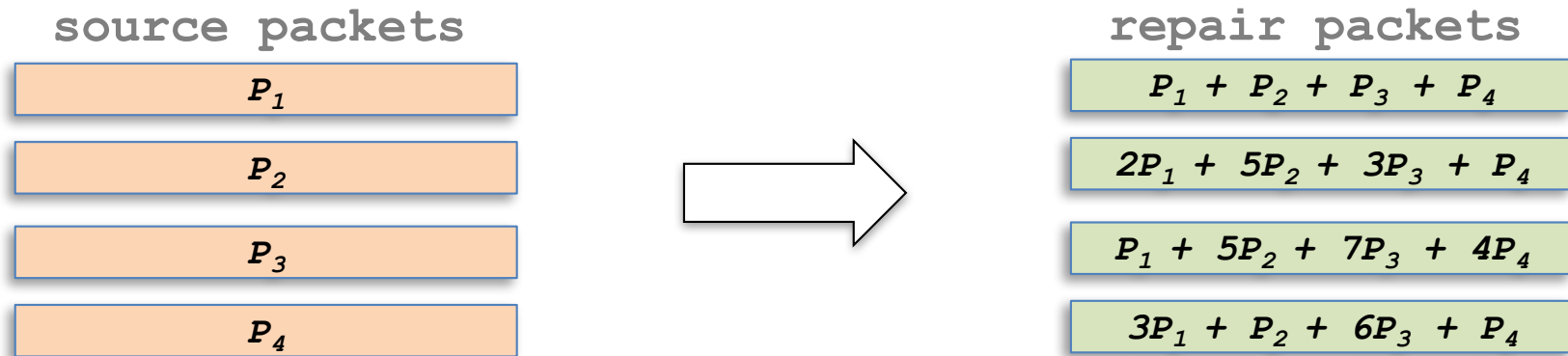
- means that a packet, when received, is assumed not to contain any bit error (thanks to various CRC/checksum verifications)

in scope

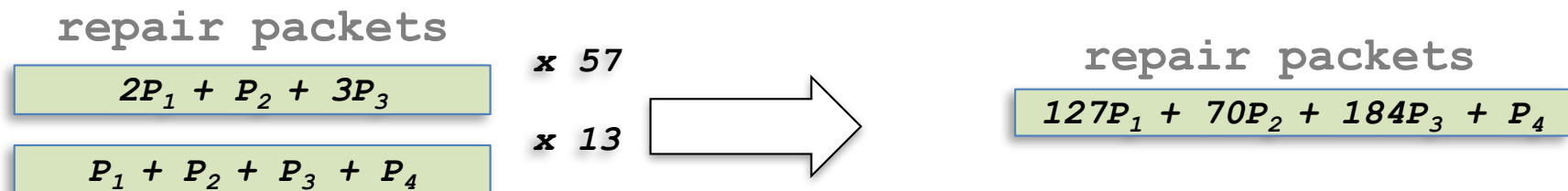
- NB: NWCRG vocabulary introduces “symbols”, but that’s a detail

Coding basics

- it's just a matter of computing a linear combination of packets
 - Example 1: combining source packets**



- Example 2: combining repair packets is feasible too**



Coding basics (2)

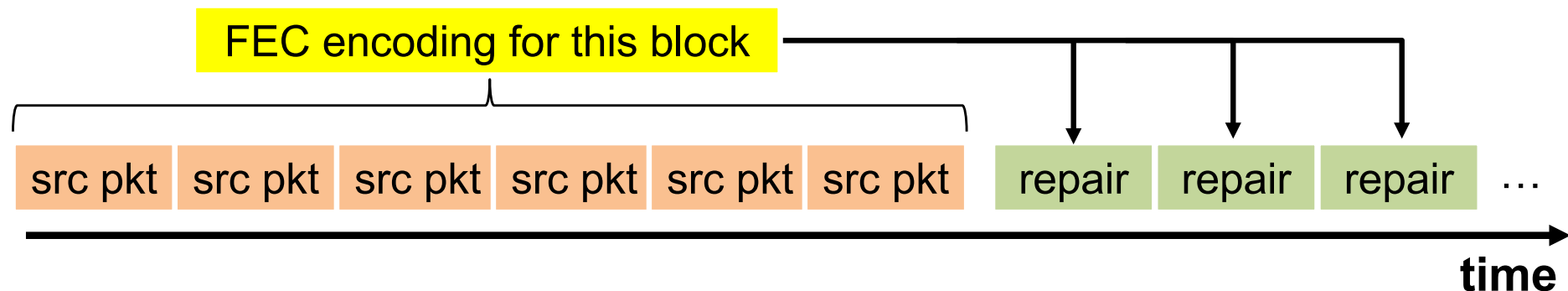
- two basic operations
 - XOR of two data chunks
 - multiplication of a data chunk by a coefficient over a certain finite field
 - e.g. over $\text{GF}(2^8)$
- that's (almost) all one needs to know at first...

NB: certain codes can be more complex (e.g., Raptor(Q) involve intermediate symbols) but that's a detail...

Block versus Window based codes

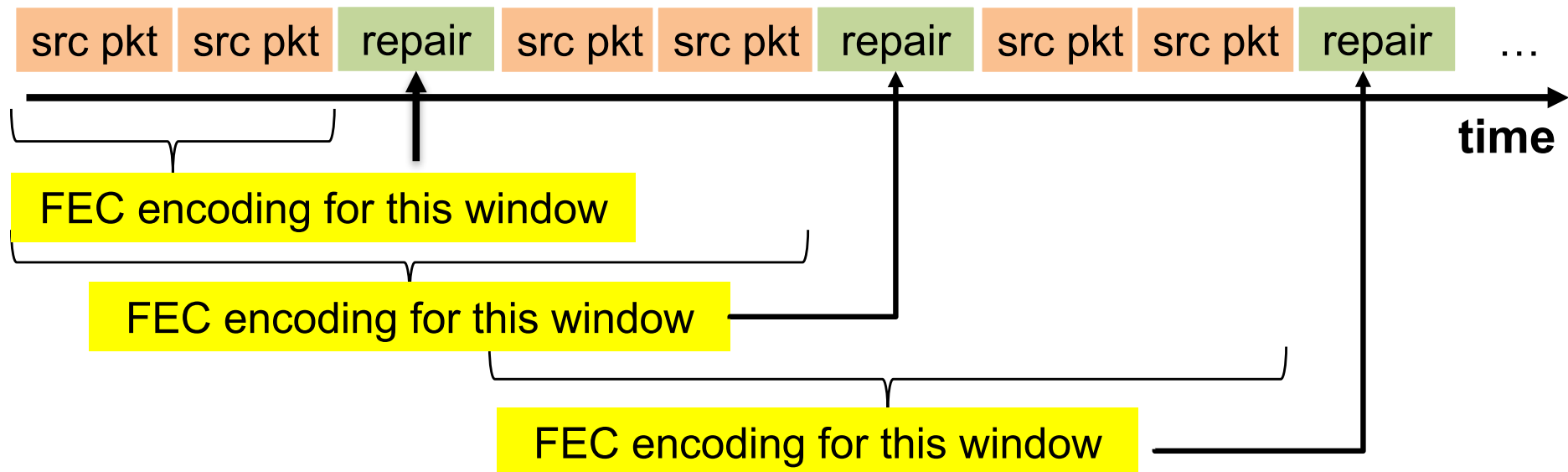
- Block codes

- segment the packet flow into blocks of a certain size, perform encoding over each block independently
- e.g., Raptor(Q), Reed-Solomon, LDPC-*, etc.
 - cf. RMT and FECFRAME (concluded) IETF WGs



Block versus Window based codes (2)

- Window based codes
 - an encoding window slides over the packet flow
 - to build a repair packet, consider packets in the current window
 - e.g. RLNC, RLC (e2e only), Fulcrum, BATS, etc.



Block versus Window based codes (3)

- Window based codes are also called...
 - **Sliding Window codes**
 - since the window slides...
 - **Elastic window codes**
 - when the window is of variable size...
 - **On-the-fly codes**
 - another name...
- compared to block codes:
 - offer a lot more **flexibility**
 - major benefits with strictly **delay-constrained flows**

More information...

- have a look at our taxonomy I-D
 - <https://datatracker.ietf.org/doc/draft-irtf-nwcrq-network-coding-taxonomy/>
 - a good place to look for further details

A small panorama for NWCRG: codes

● RLNC

- a fundamental component of “Network Coding”
- capable of doing in-network re-coding
- **no IETF/IRTF specification**

● Fulcrum network codes

- capable of doing in-network re-coding
- IETF 91 presentation
- <https://www.ietf.org/proceedings/91/slides/slides-91-nwcrg-1.pdf>

● BATS

- capable of doing in-network re-coding
- IETF 89 presentation
- <https://www.ietf.org/proceedings/89/slides/slides-89-nwcrg-5.pdf>

● RLC

- **limited to end-to-end** (same as block codes)
- TSVWG (work in progress), to be used with FECFRAME
- <https://datatracker.ietf.org/doc/draft-ietf-tsvwg-rlc-fec-scheme/>

A small panorama for NWCRG: protocols

● Tetrys

- mostly end-to-end
- expired ID exists (needs an update)
- <https://datatracker.ietf.org/doc/draft-detchart-nwcrq-tetrys/>

● Dragoncast

- in-network re-coding capable
- expired ID exists (needs an update)
- <https://datatracker.ietf.org/doc/draft-adjih-dragoncast/>

● FECFRAME extended

- **limited to end-to-end** (initially limited to block codes, extended to sliding window codes)
- TSVWG (work in progress)
- <https://datatracker.ietf.org/doc/draft-ietf-tsvwg-fecframe-ext/>

Conclusion

- many research outcomes
- time to transition to application and protocol research
 - **one of the goals of NWCRG**
 - **links with other RG and WG to foster outcomes**