Cryptography on multicore systems: an Erlang case

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Programming on multicore systems

Available number of cores already enormous

- Tilera: 512 cores in 2U server < 250W now [1]

Shared-memory coding doesn't work

- Minimizing locking is critical and essential
- State must be moving around with functions
  - Message passing will be the (casual) solution

Crypto (RNG, hashing) = full of states

- **Code with hidden states is not reentrant and unusable in the multicore systems!**

[1] http://www.tilera.com/about_tilera/press-releases/tilera-double-processor-cores-every-two-years

My experience of SFMT RNG on Erlang

Making the C code reentrant

http://github.com/jj1bdx/sfmt-extstate

Writing a pure Erlang version of SFMT

Writing a NIF version of Erlang SFMT

with the reentrant C code

~40 times faster than the pure Erlang code

Available in Github at

http://github.com/jj1bdx/sfmt-erlang

Acknowledgment

Kyoto University Super Computer Thin Cluster has been extensively used for the code testing and development of the sfmt-erlang software.

How Erlang BEAM (VM) runs crypto

- Based on OpenSSL
- More CPU core alloc control by BEAM
  - Long ago: single-thread linked-in driver
  - Previous: multi-thread linked-in driver
  - Now (since R14A) NIF
    - Native Interface Functions: part of BEAM in C
    - Mapped onto BEAM processes for max parallelism
- Lesson learned: let the application (or the VM), not the OS, control the CPU core scheduling

Crypto for concurrent/parallel systems

Split the en/decrypting data for parallelism

- MS Office 2007 SP2 uses 4096-byte cipher block and uses a new key for each [2]
  - To ensure random access and recoverability
  - This approach also applicable to multicore crypto

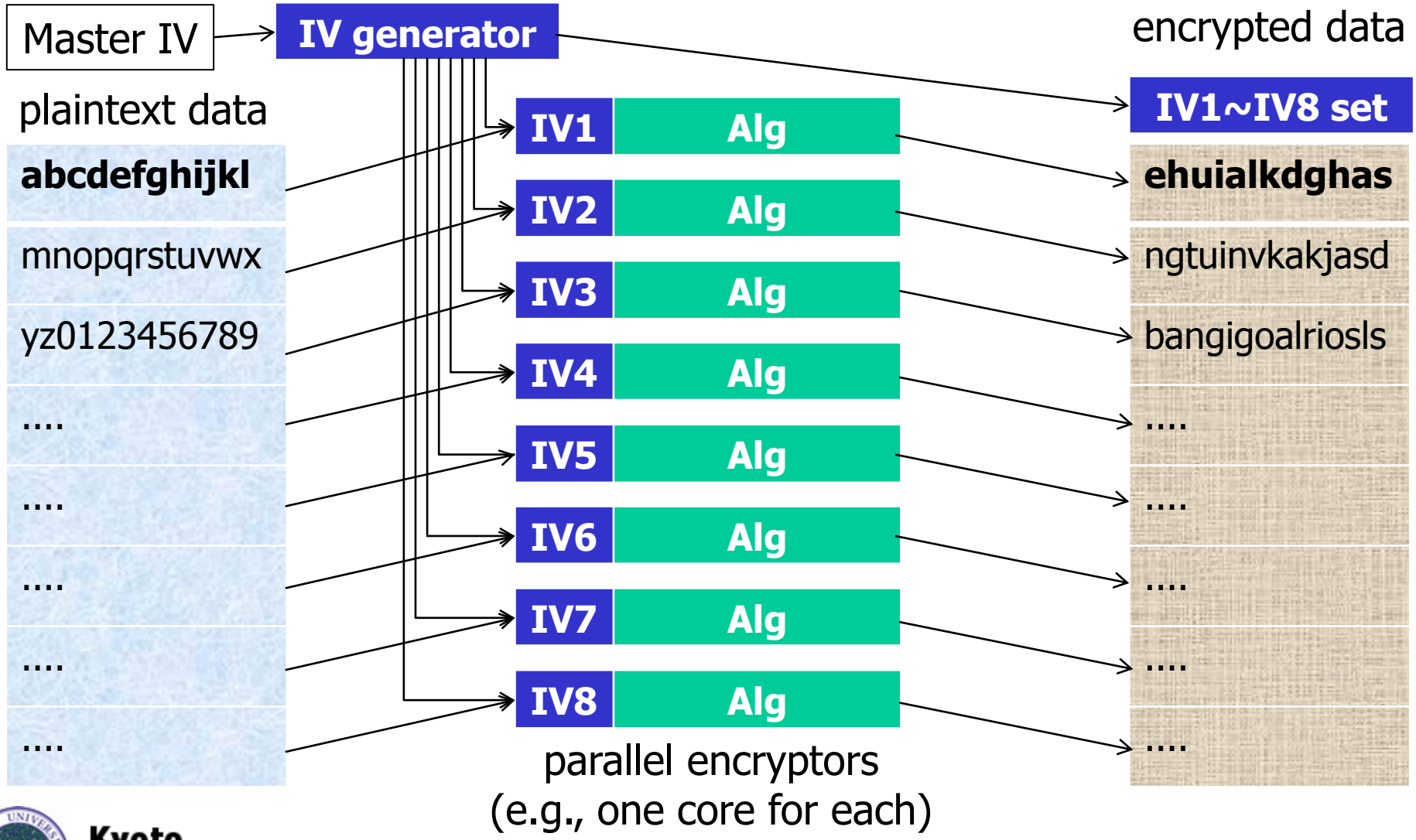
Keeping states and data intact

- Keep `{IV, Algorithm, <<Data>>}` together
  - Algorithm: Key+Crypto / Hash func / RNG, etc.

[2] M. Howard, D. LeBlanc, J. Viega, "24 Deadly Sins of Software Security", McGraw-Hill, 2010, ISBN 978-0-07-162675-0, Sin 21, Page 329.

An example of parallel encryption

Splitting data into multiple blocks enables applying parallelism to encryption



My questions to the crypto experts

Any parallel-oriented crypto algorithms?

- More speed if many cores are fully utilized

Asymmetric multiprocessing needed?

- Typical applications: parallel IDS/packet filter
- Core assignment for the optimal performance?

Multi-platform compatible algorithms?

- not only x86(-64); ARM, Tilera, GPGPU, etc.

The last question: are you ready?