Information Centric Things

Running ICN over RIOT

Marcel Enguehard
Software Engineer and PhD Candidate
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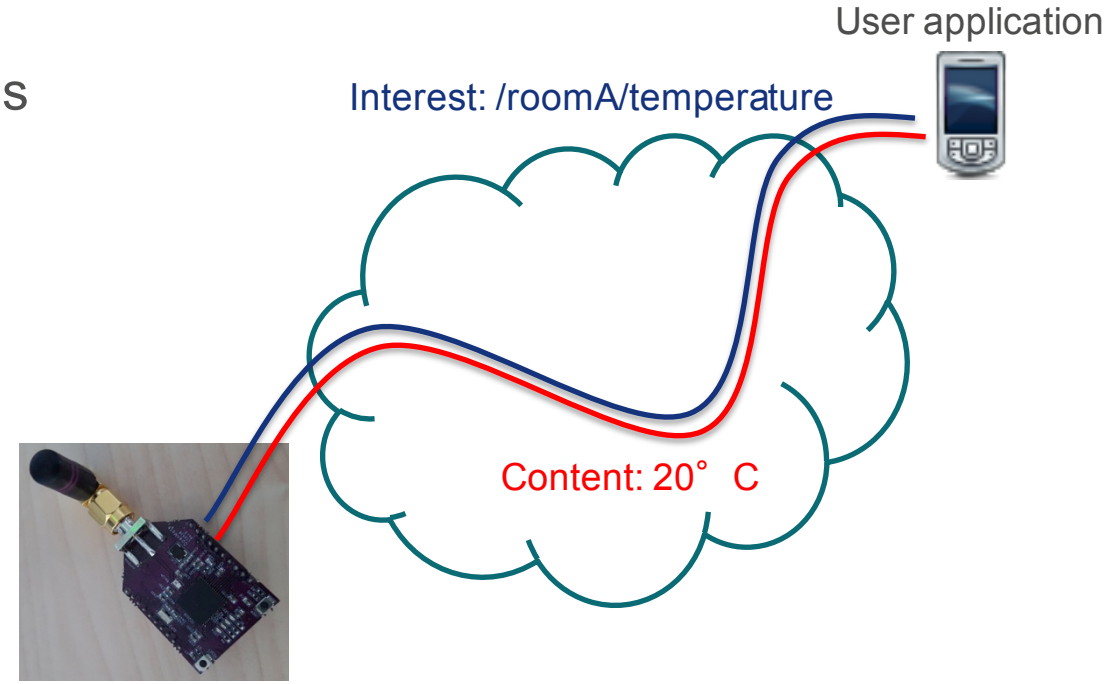
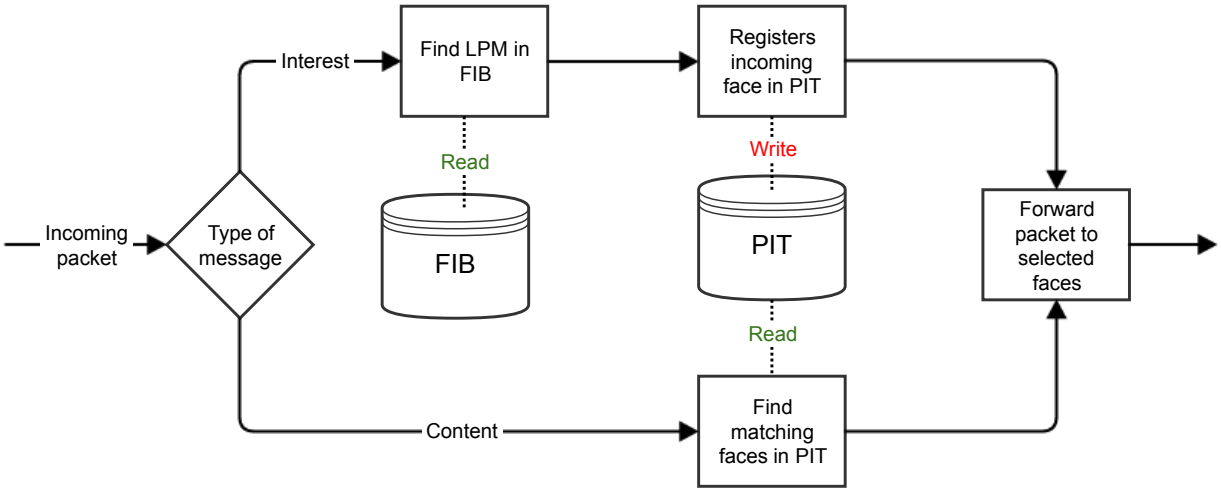
Information Centric Networking

- Each retrievable content is named
- Name-based routing
- Pull based model
- Symmetric routing
- Every node is a cache



Vanilla ICN Forwarding

- Forward to “faces”
- 2 modules: Forwarding Interest Base (FIB) and Pending Interest Table (PIT)
- Interest → LPM in FIB
- Content → Symmetric routing through PIT

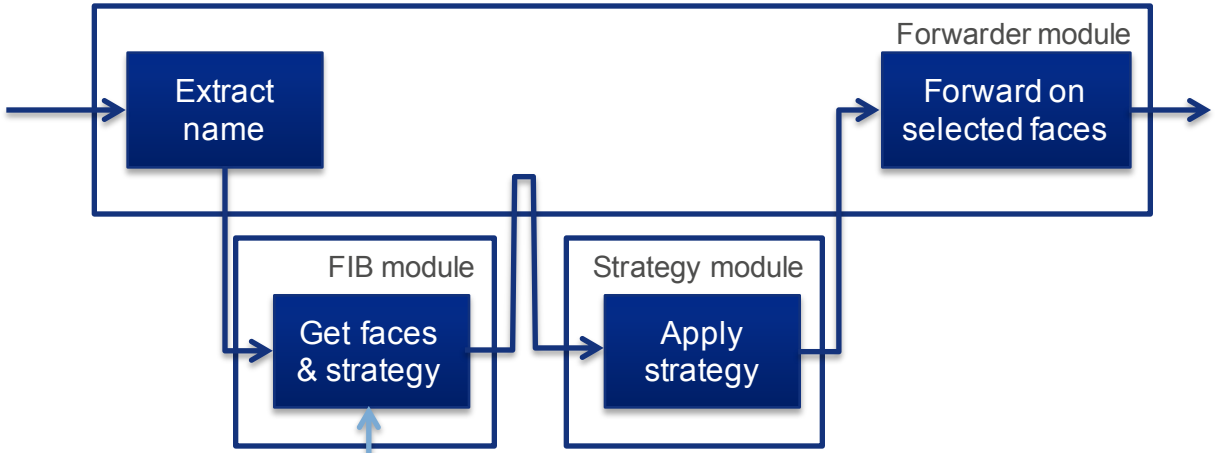


Cisco ICN-IoT stack

- In-house implementation of ICN over RIOT
- Built for modularity and functionality:
  → based on modules (FIB, PIT, name mgmt,…)
- ~ 5k lines of code & 3 threads (main, rx/tx and beaconing)
- No cache
- W/o optimizations:
  - RAM: 23KB
  - ROM: 63KB

Dynamic forwarding

- FIB entries can point to multiple faces
- Face selection is applied through “strategies”
- e.g., Geographic forwarding




```
typedef struct iot_fib_entry_s {
   uint8_t face_list[nb_faces];
   iot_name_t prefix;
   strategy_callback_t strategy;
} iot_fib_entry_t;
```

Geographic Forwarding in WSN

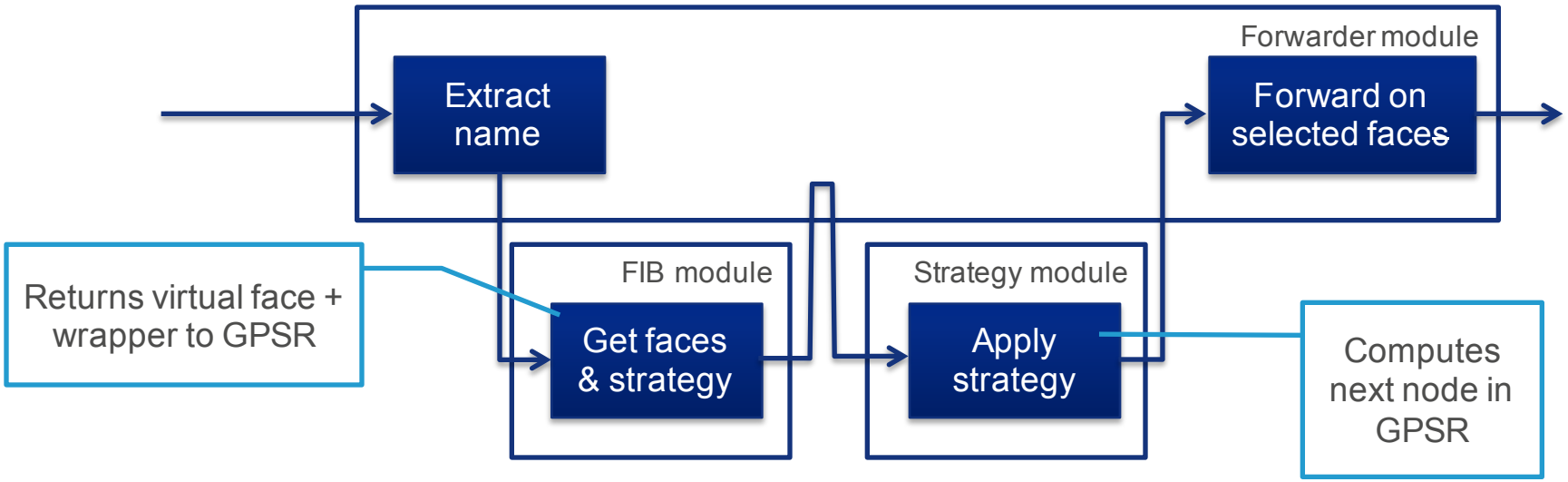
- Forward to geographic location
- Forwarding based on local properties
- Sensor-friendly
- Our flavour: GPSR

Geographic forwarding for ICThings

- Data name: `/g/locinf/rest/of/name`
- FIB entry for `/g/`:
  - Face: virtual face (all neighbours)
  - Strategy: GPSR
- TLV for additional information

Bits	1-7	8-15	16-23	24-31	32-39	40-47	48-55	56-63	64-71	72-79	80-87
Field	GPSR opcode	Length (88)	FLAGS	Perimeter entry x-coordinate				Perimeter entry y-coordinate			

Geographic forwarding for ICThings – cont'd

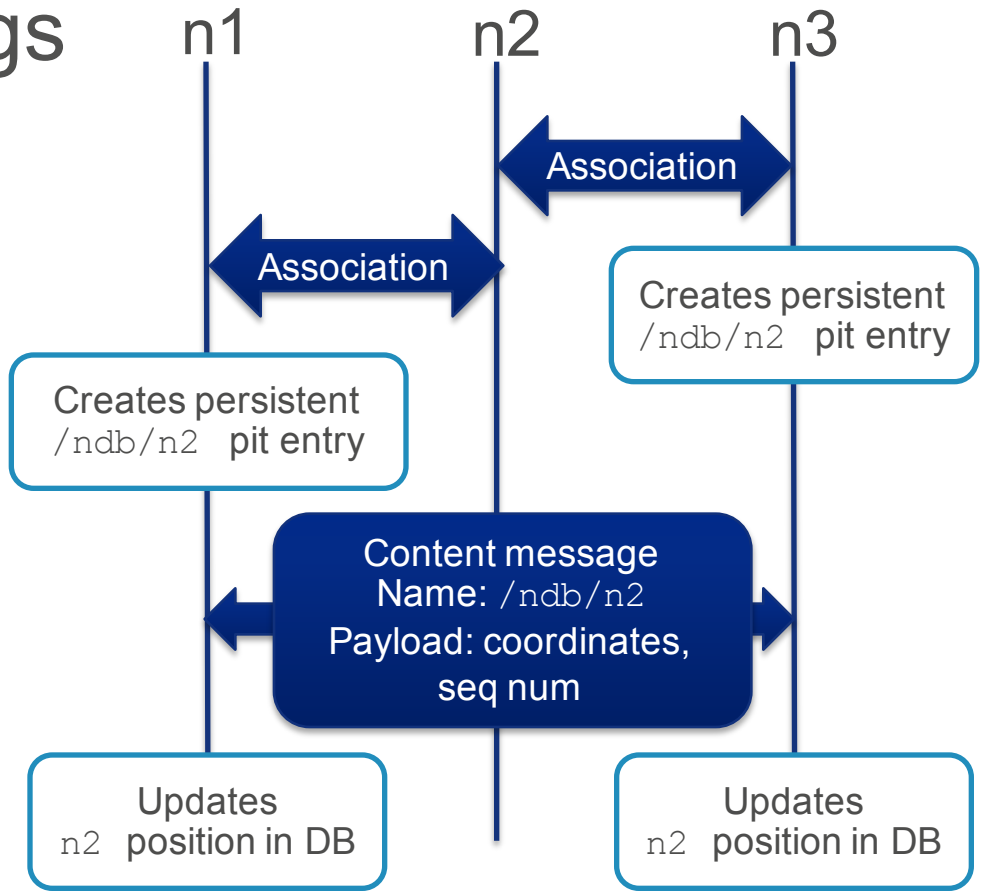


Beaconing for ICThings

Neighbourhood + location updates

Association: See [1]

Encryption through AES broadcast keys

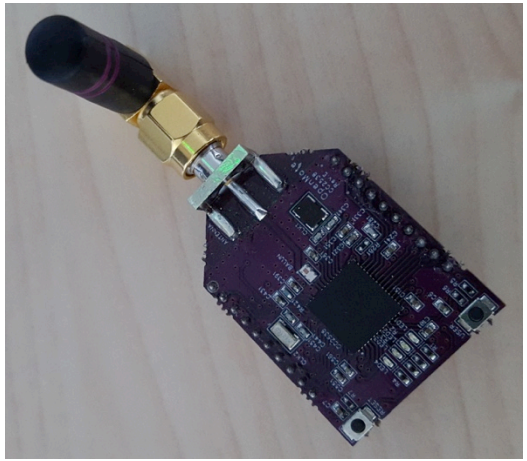


[1] A. Compagno, M. Conti and R. Droms. OnboardICNg: a secure protocol for on-boarding IoT devices in ICN, To appear at ACM ICN'16

Our IoT hardware

OpenMote

- ARM Cortex-M3 @ 32MHz
- AES+ECC hardware support
- 32KB RAM
- 512KB ROM
- Open source design

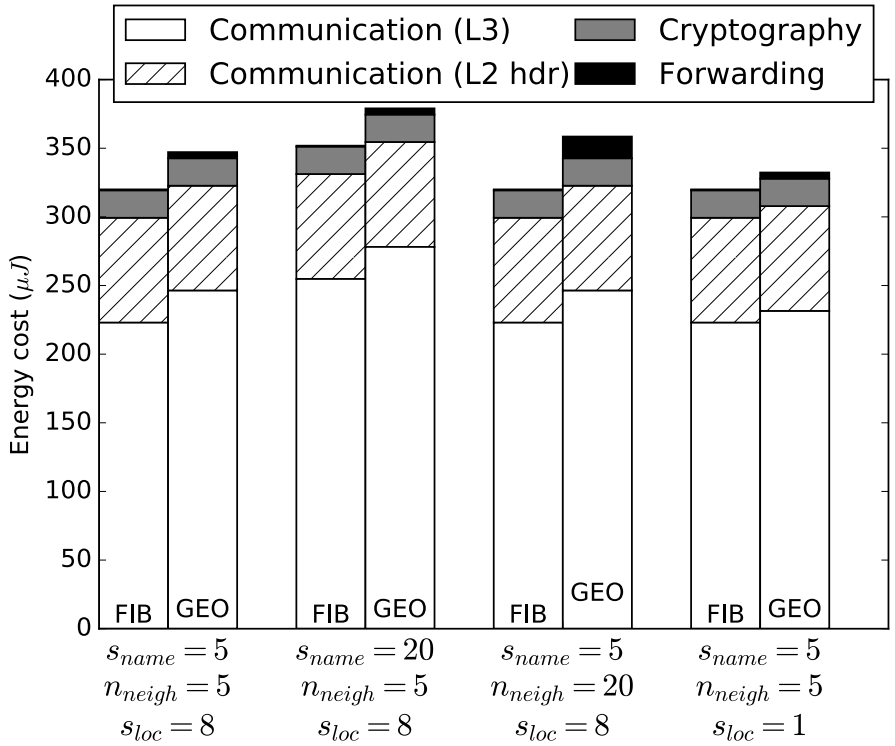


Evaluation setup

Cycle counter in M3

```
#include <cc2538.h>
#include <stdint.h>


int main () {

    uint32_t nb_cycles;

    //Enables debug
    CoreDebug->DEMCR |= _VAL2FLD(CoreDebug_DEMCR_TRCENA,1);
    //Enables cycles counter
    DWT->CTRL |= _VAL2FLD(DWT_CTRL_CYCCNTENA,1);

    populate_tables ();

    //Reinitialises cycle counter
    DWT->CYCCNT = 0;
    perform_test ();
    nb_cycles = DWT->CYCCNT;

    ...
}
```

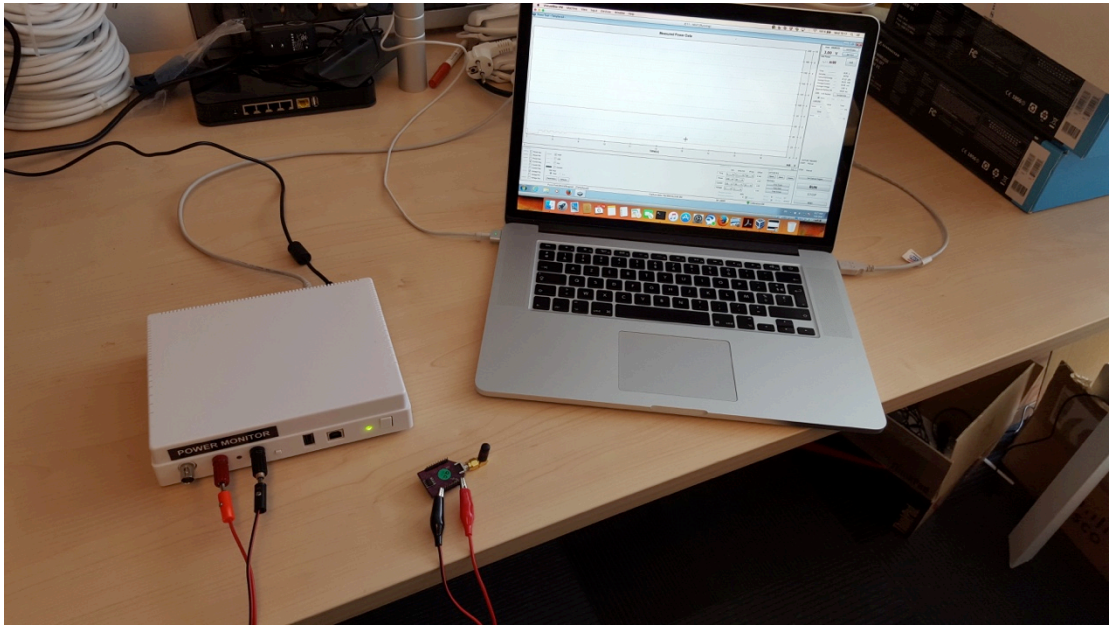
Forwarding vs cryptography/communication



Communication & cryptography costs estimated thanks to:
Shafagh et al. *Talos: Encrypted Query Processing for the Internet of Things*, SenSys' 15

Going forward

Power Monitor plugged on VCC and GND pins on the OpenMote



Going *forwarder*

- Full-scale evaluation
  - Micro-benchmark of all energy values
  - Going fullscale: testbed/emulation?
  - Cost of control traffic
- Limits of GPSR
  - Optimizing neighbour count
  - Hyperbolic routing

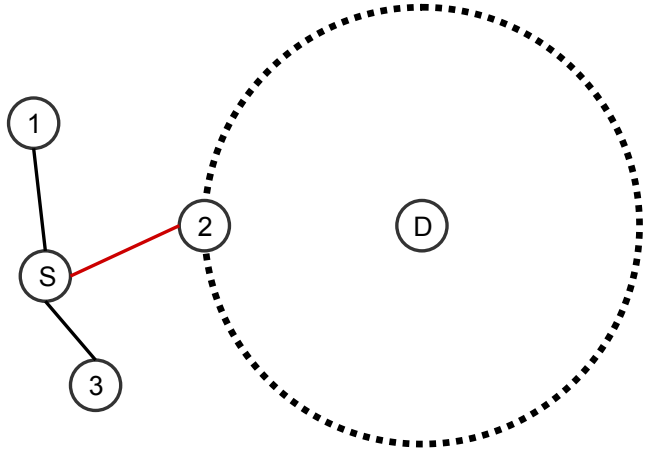
Reflecting on RIOT

- Programming made easy
  - Avoid lots of painful things (shell, crypto, network)
  - Wiki is very helpful (thanks to the community ;-))
  - (almost) Portable code from one platform to another
  - Modules' system
  - Native mode
- Hardware support not yet complete
  - e.g., encryption modules

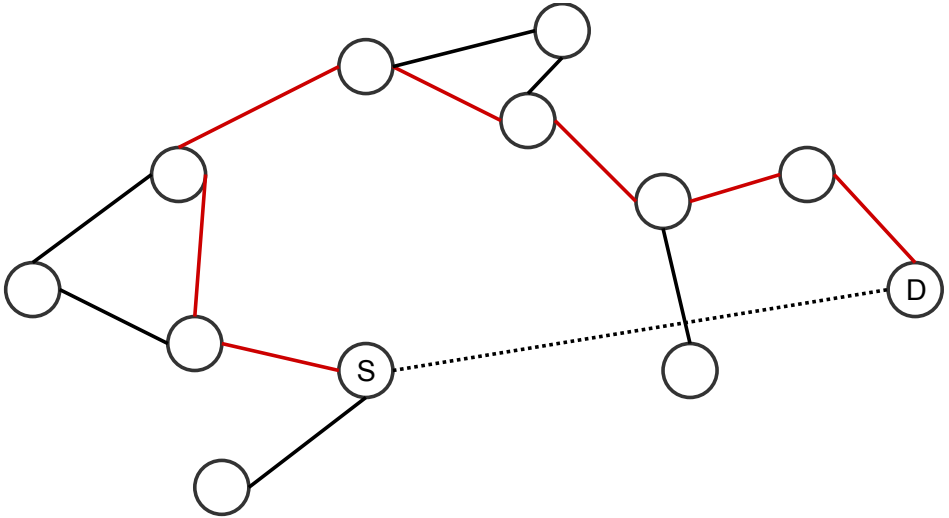

CISCO

GPSR – Greedy and perimeter mode

Greedy forwarding



Perimeter forwarding



Memory & CPU consumption