



IoT Network Research at LIG

Drakkar Team

Andrzej Duda

LIG

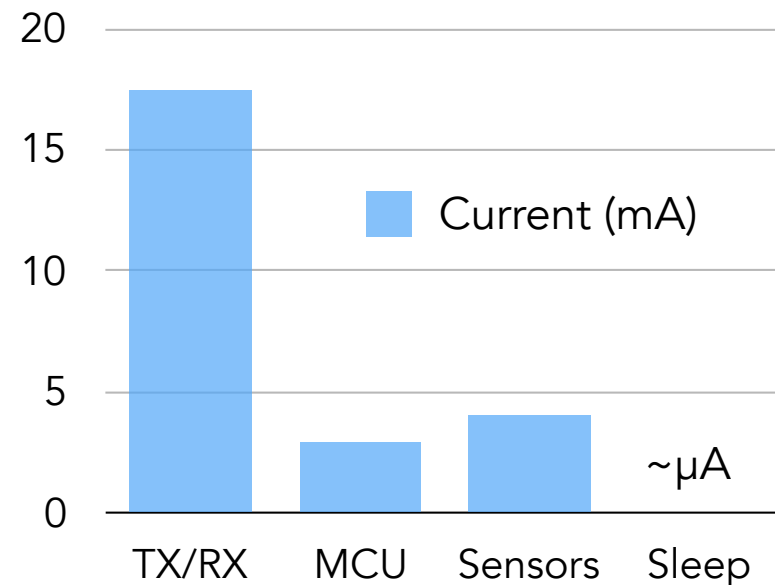
Grenoble-INP - Ensimag

Overview

- **Drakkar Team**
- IoT - comparison of **energy consumption** in IoT networks
- Issues in **capillary IoT networks - routing**
- Issues in **cellular IoT networks - access methods**
- **Security**
- **Reproducibility - WaIT platform**



Example TI MCU



Drakkar Team

Drakkar Team

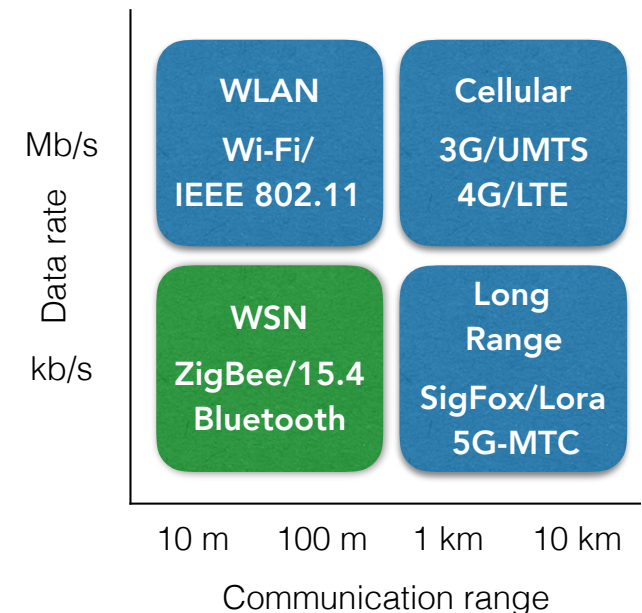
- **Head**
 - Andrzej Duda, PR Grenoble INP
- **Permanent staff**
 - Olivier Alphand, MC Grenoble INP
 - Etienne Dublé, IR CNRS
 - Martin Heusse, PR Grenoble INP
 - Franck Rousseau, MC Grenoble INP
 - Pascal Sicard, MC UGA
 - Bernard Tourancheau, PR UGA
- **14 PhD students**



*"That is about as fun
as **herding cats**"*

Main domains

- **Wireless networks**
 - WLANs 802.11, advanced MAC
- **IoT - Sensor & actuator networks**
 - all-IP, LPWAN
 - MAC, routing, data-centric
- **Security, traffic analysis**
 - anomaly detection, DNS cybersecurity
 - security of IoT



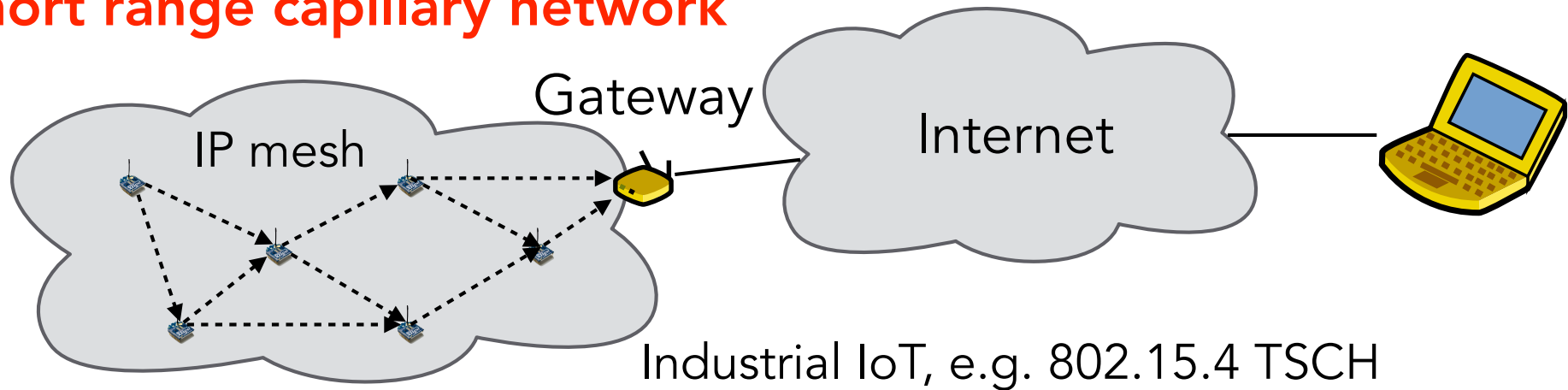
Main results

- **802.11 Performance Anomaly**
 - INFOCOM 2003
- **Idle Sense, an optimal 802.11 access method**
 - ACM SIGCOMM 2005
- **Recent INFOCOM papers**
 - Wake-on-Idle
 - Detecting applications in encrypted flows
- **IEEE TMC, ACM CCR**
- **TPC**
 - Infocom

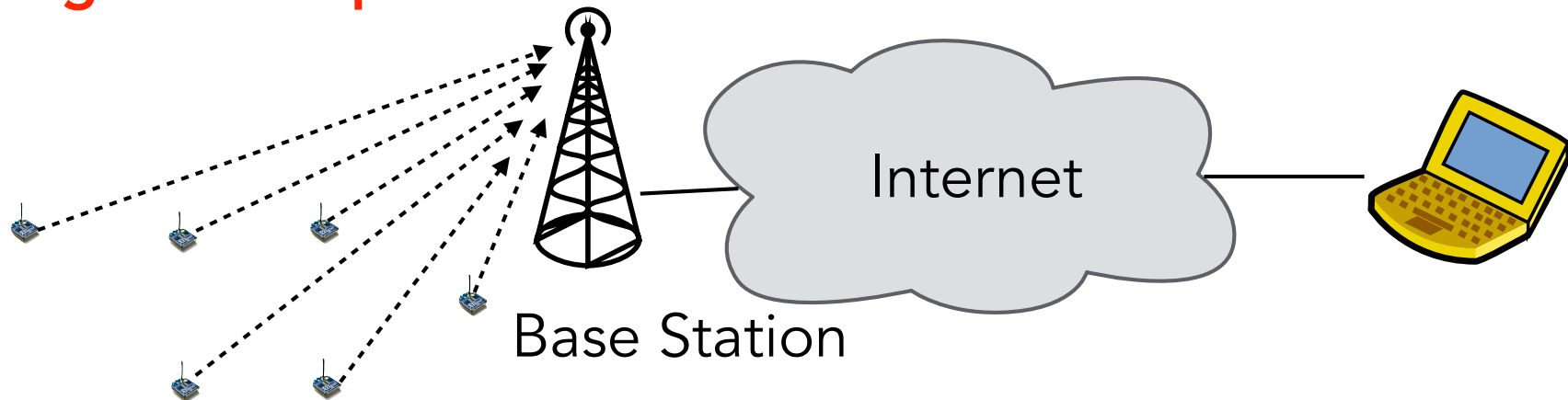
IoT - comparison of energy consumption in IoT networks

Capillary vs. Cellular

Short range capillary network

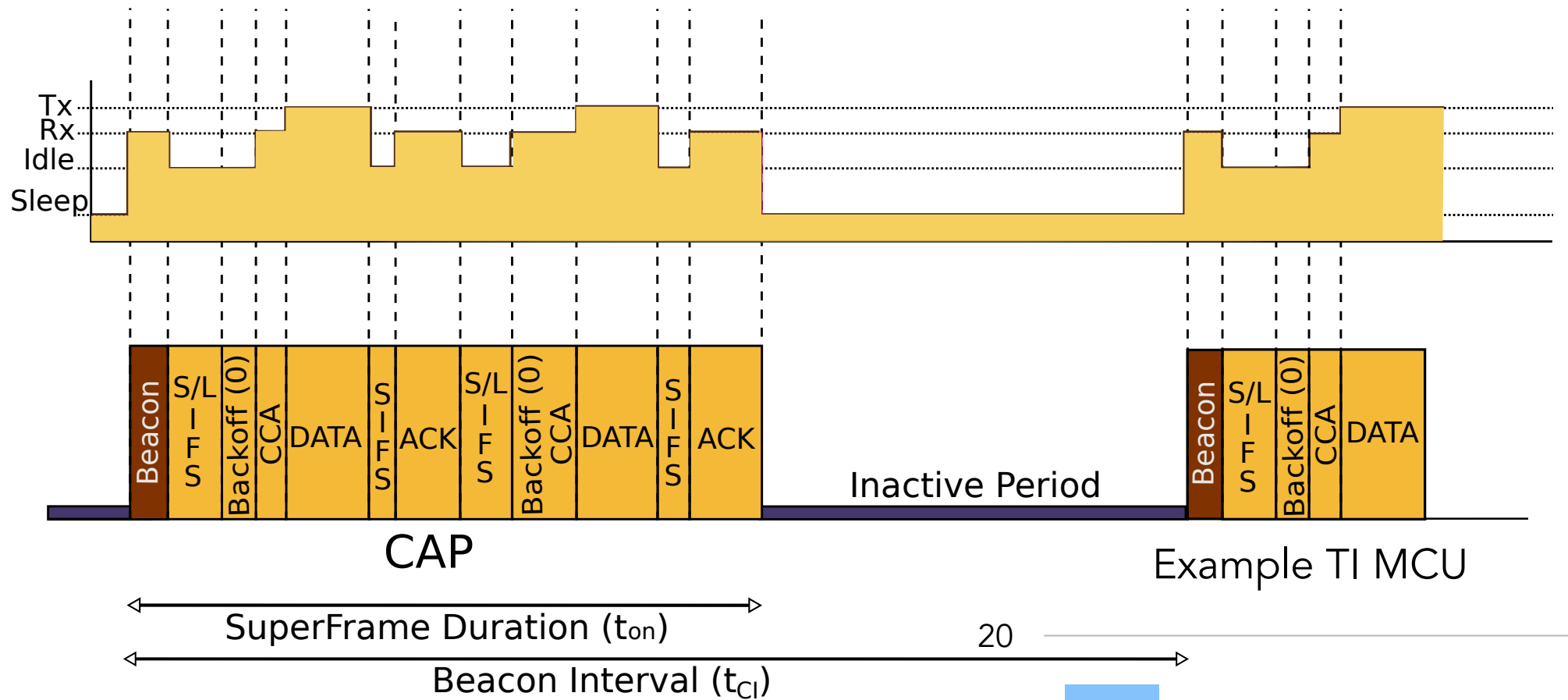


Long range one-hop network



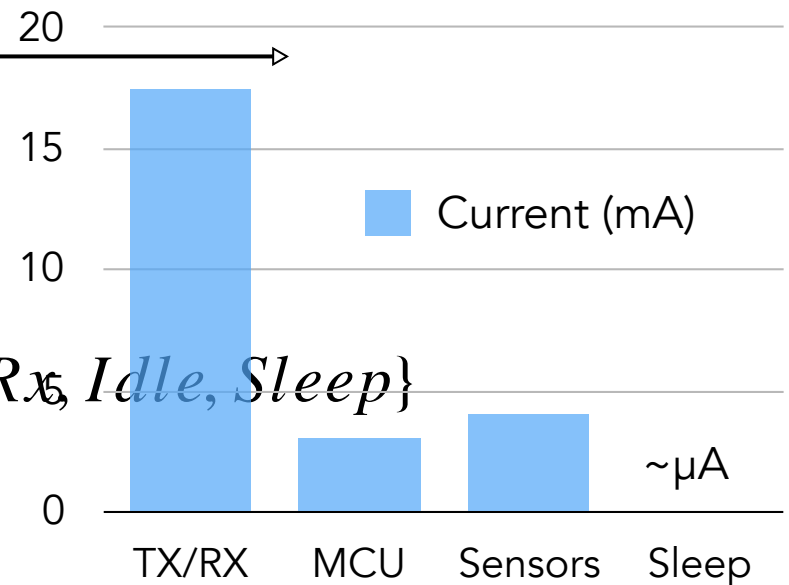
Proprietary Protocols
e.g. LoRa, SIGFOX

Energy consumption in 802.15.4

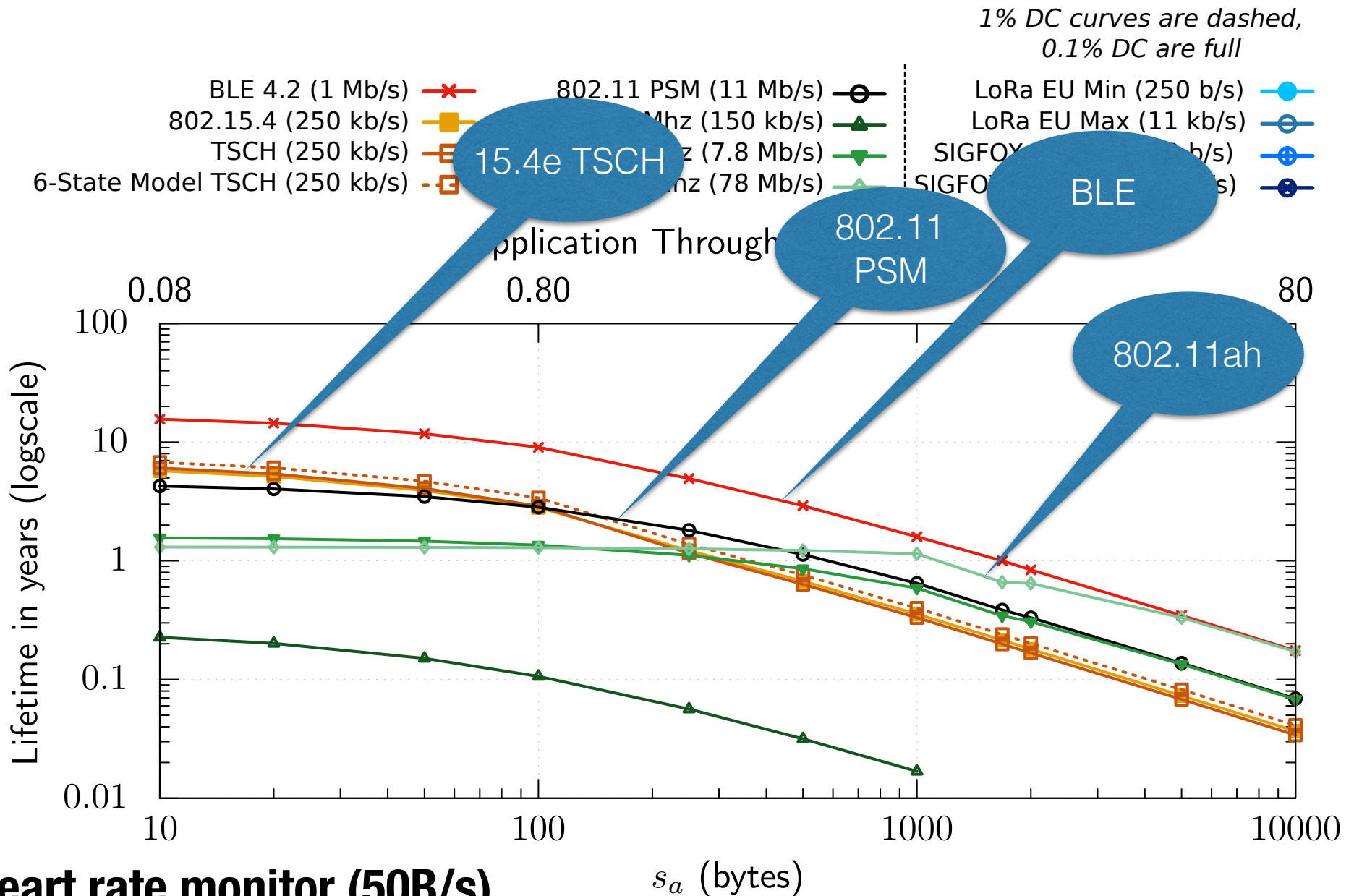


- Energy consumption**

$$E(t) = \sum_S P_S \times t_S, \quad S \in \{Tx, Rx, Idle, Sleep\}$$



Lifetime, 1 pkt per 1s

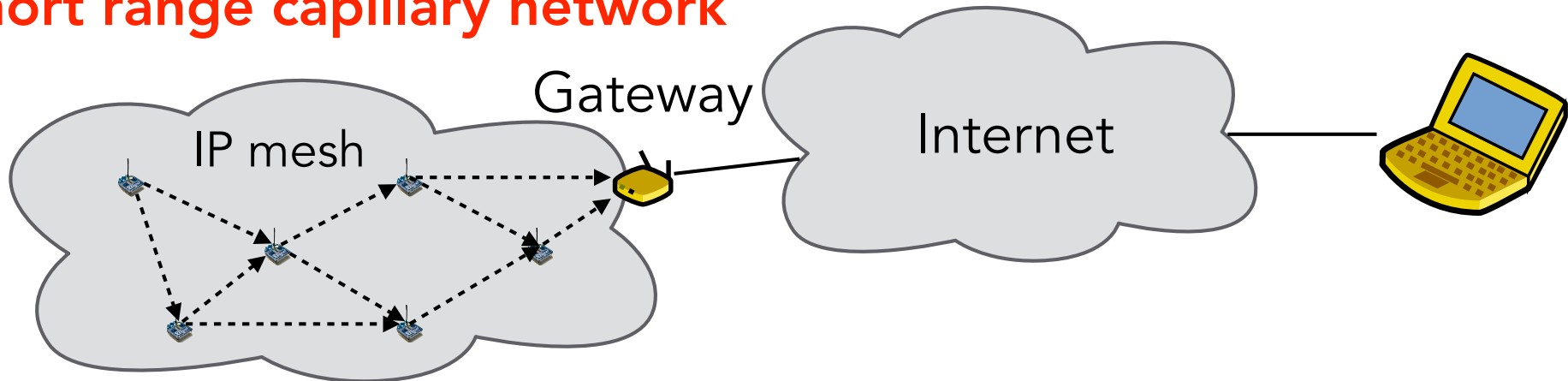


- Heart rate monitor (50B/s)

Issues in cellular IoT networks - routing

Issues in Capillary

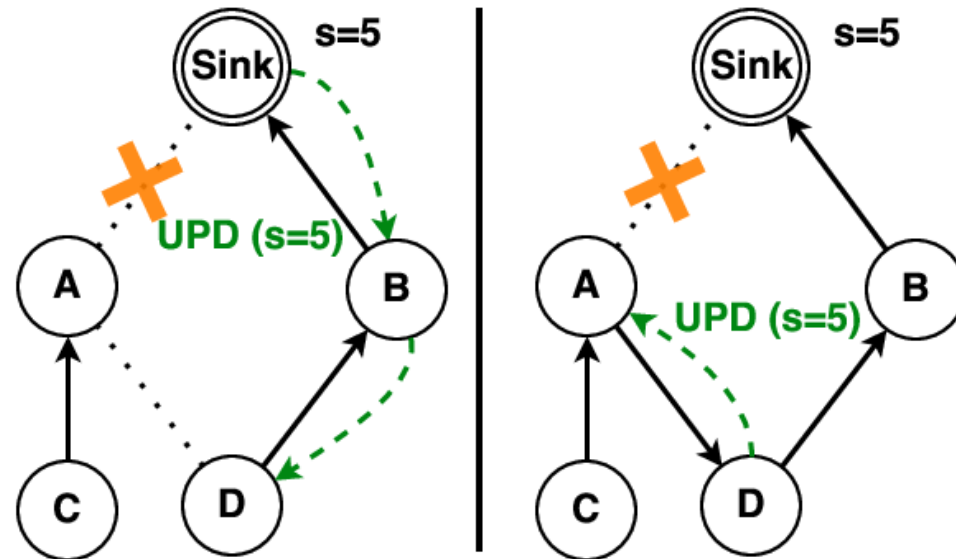
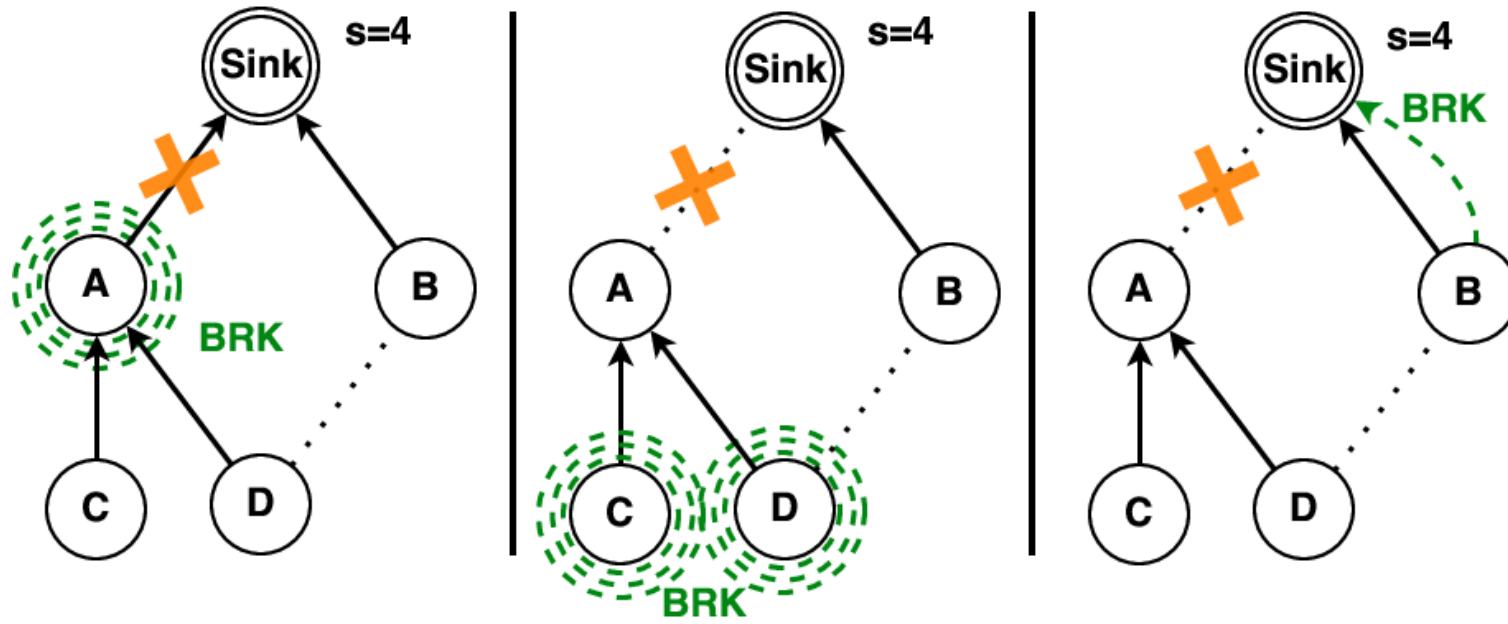
Short range capillary network



- **Needs a routing layer for IP mesh**
 - **RPL** (Routing Protocol for Low power and Lossy Networks)
 - IETF standard
 - **LRP** (Lightweight Routing Protocol) - enhanced RPL

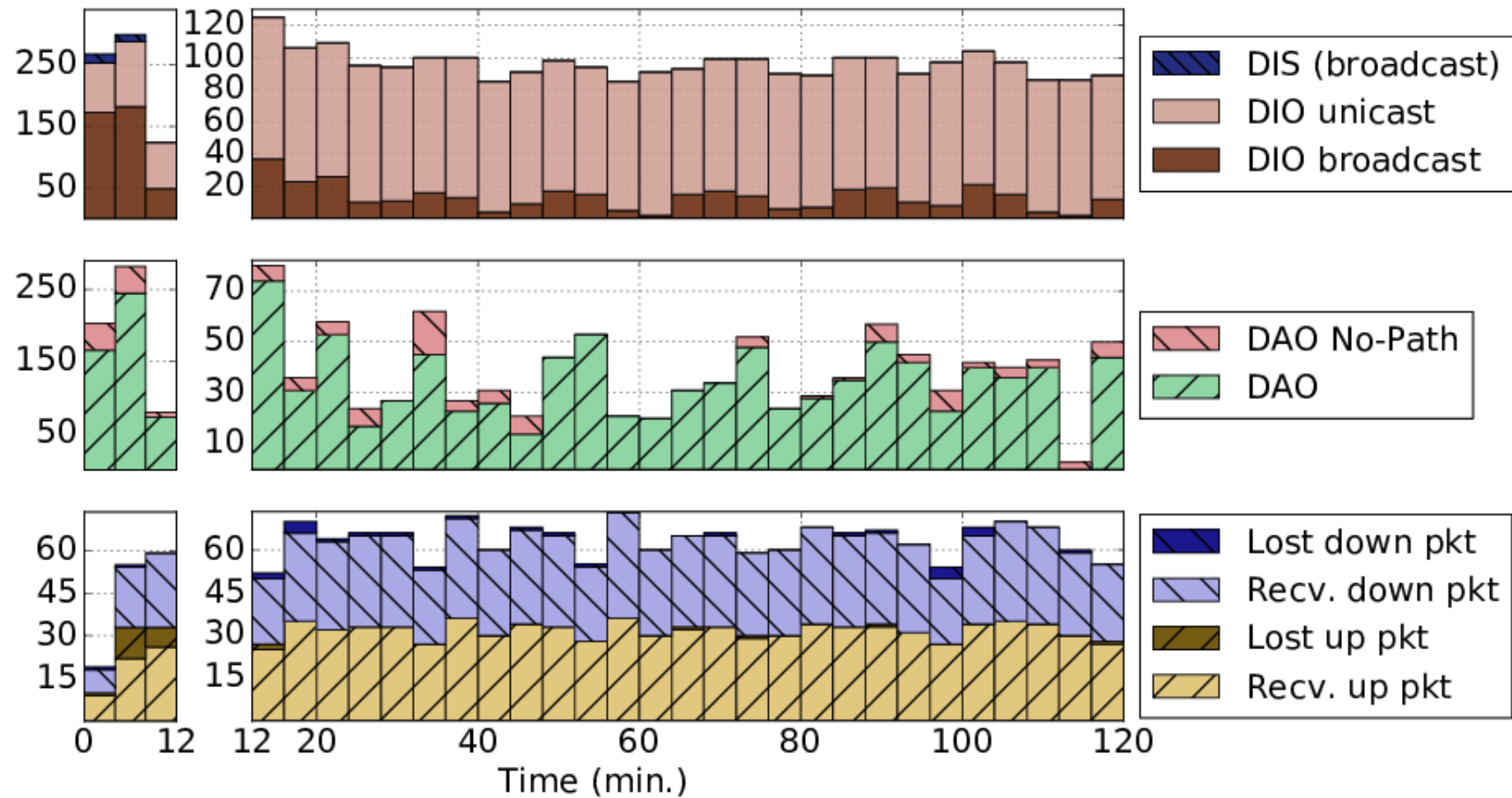
LRP in a word

Local Repair



RPL

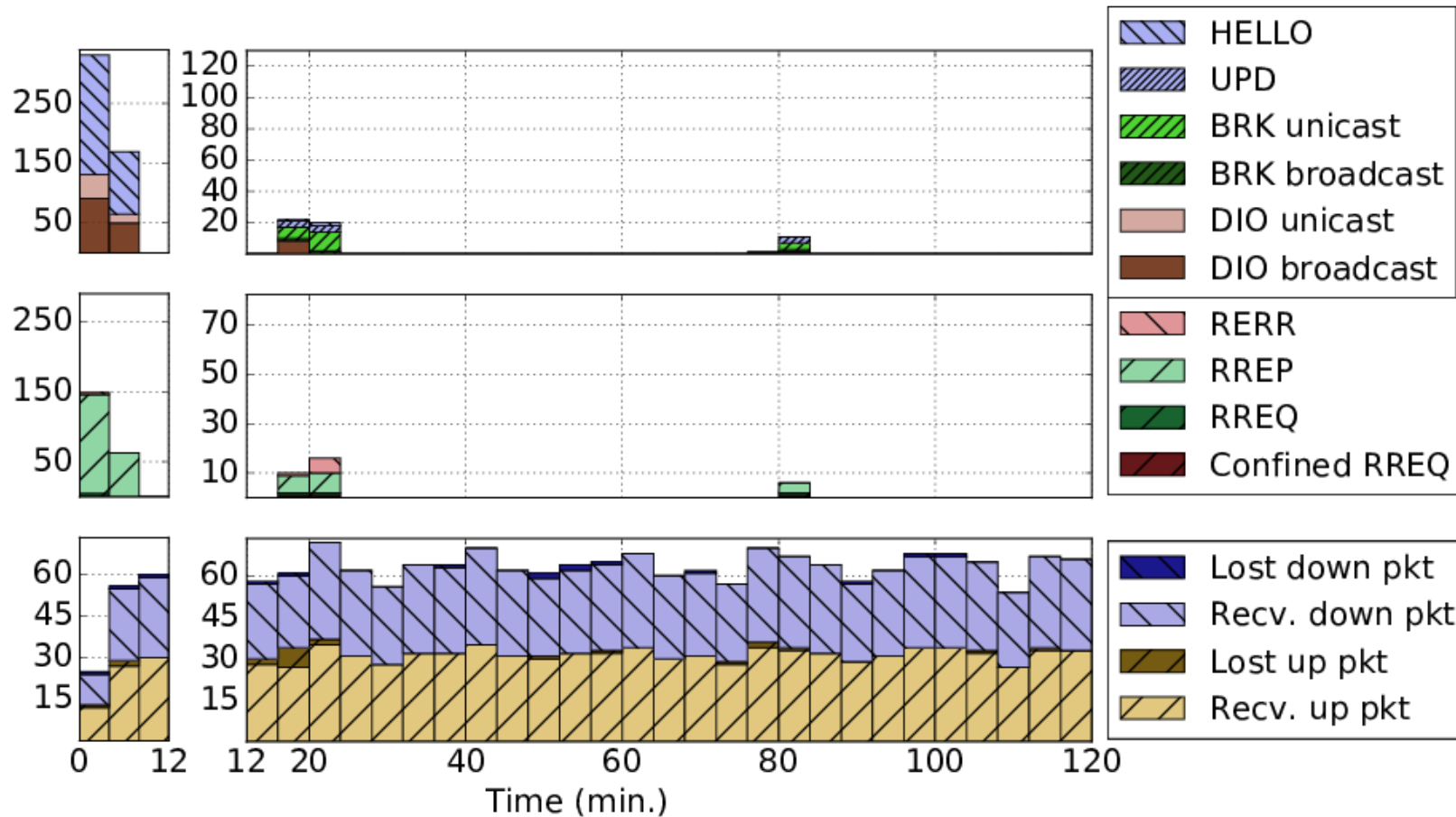
Protocol Background Traffic



RPL — 1 sink, 40 nodes

LRP

Protocol Background Traffic

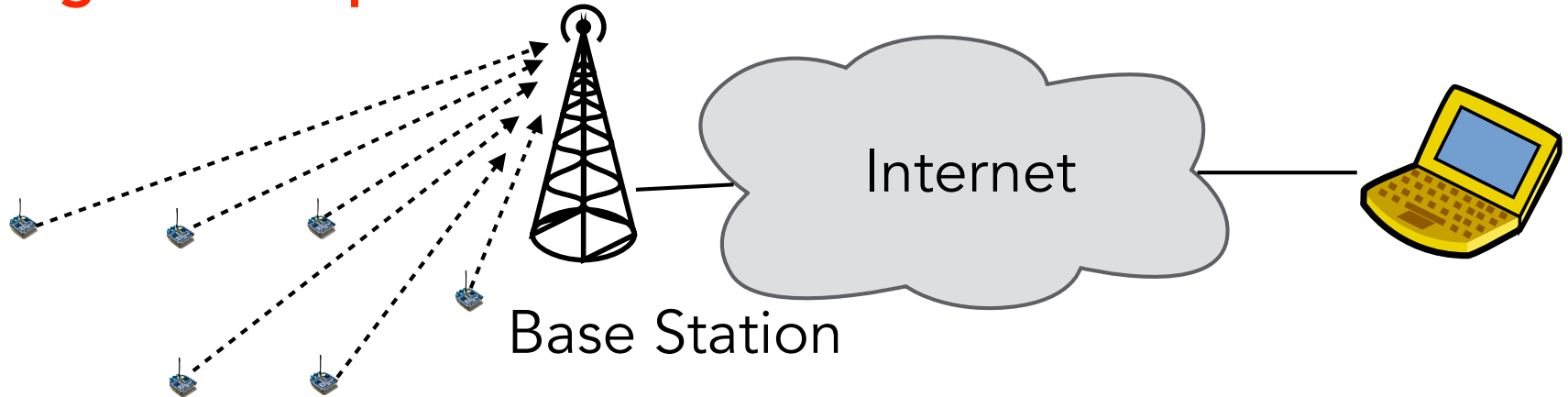


LRP — 1 sink, 40 nodes

Issues in cellular IoT networks - access methods

Issues in Cellular

Long range one-hop network

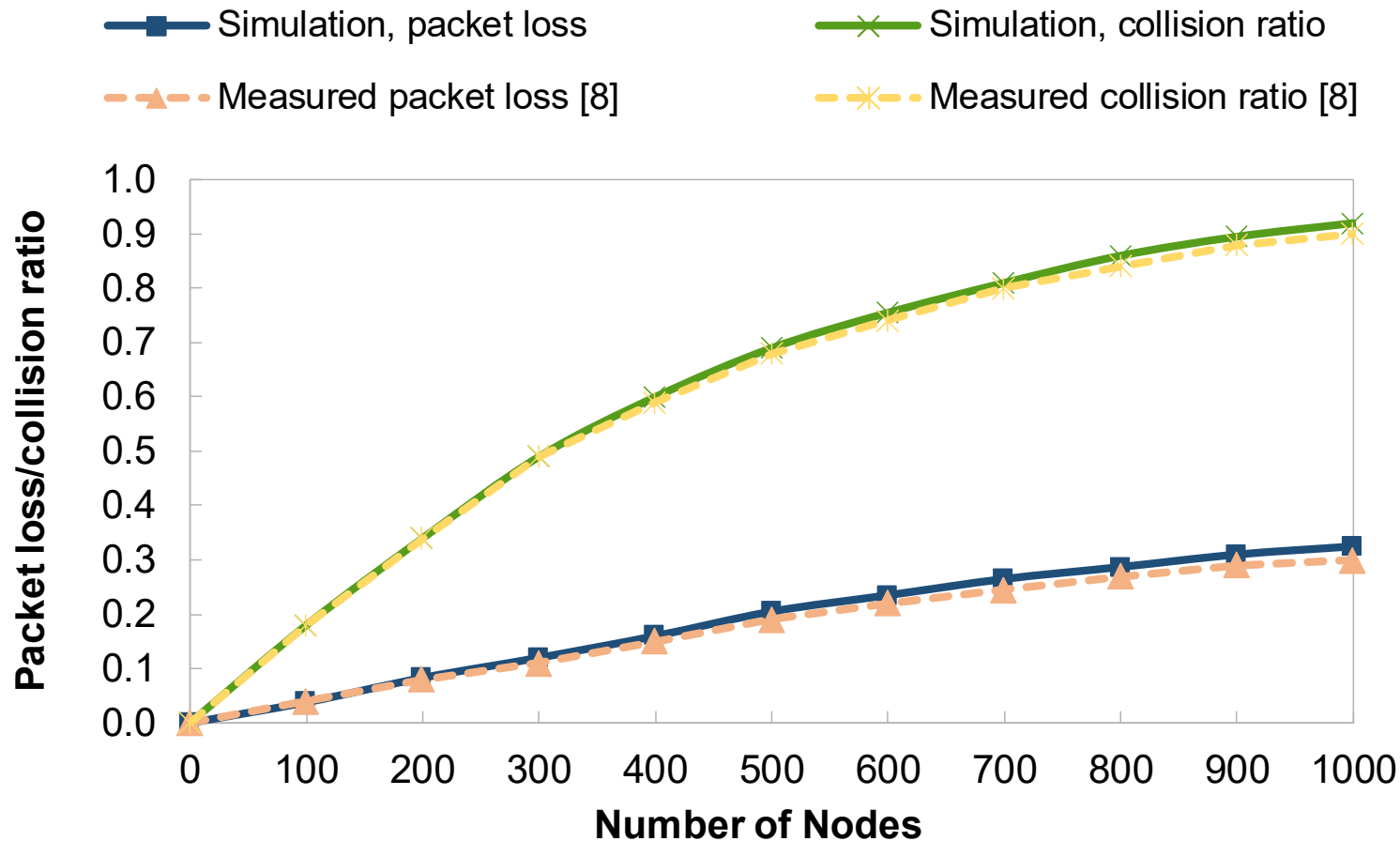


Proprietary Protocol
e.g. LoRa

- **Needs a scalable access method**

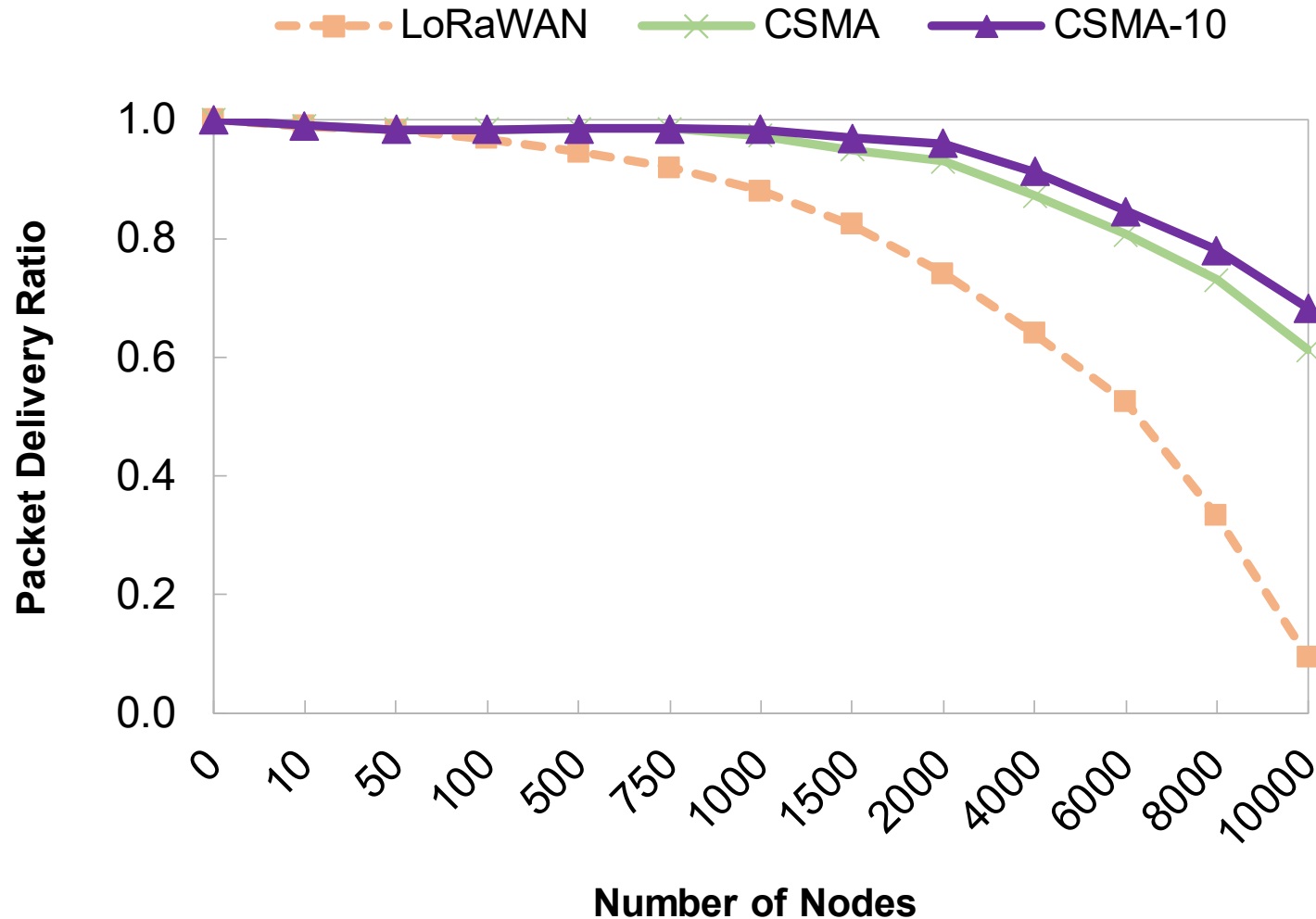
- LoRa, SIGFOX - **no access method (ALOHA)**, limited traffic (e.g. 1 pkt. per day)
- 5G MTC - what access method?
 - need for **scalable access**

NS-3 module for LoRa



- **Take into account capture effect - lower loss rate than in ALOHA**

NS-3 module for LoRa



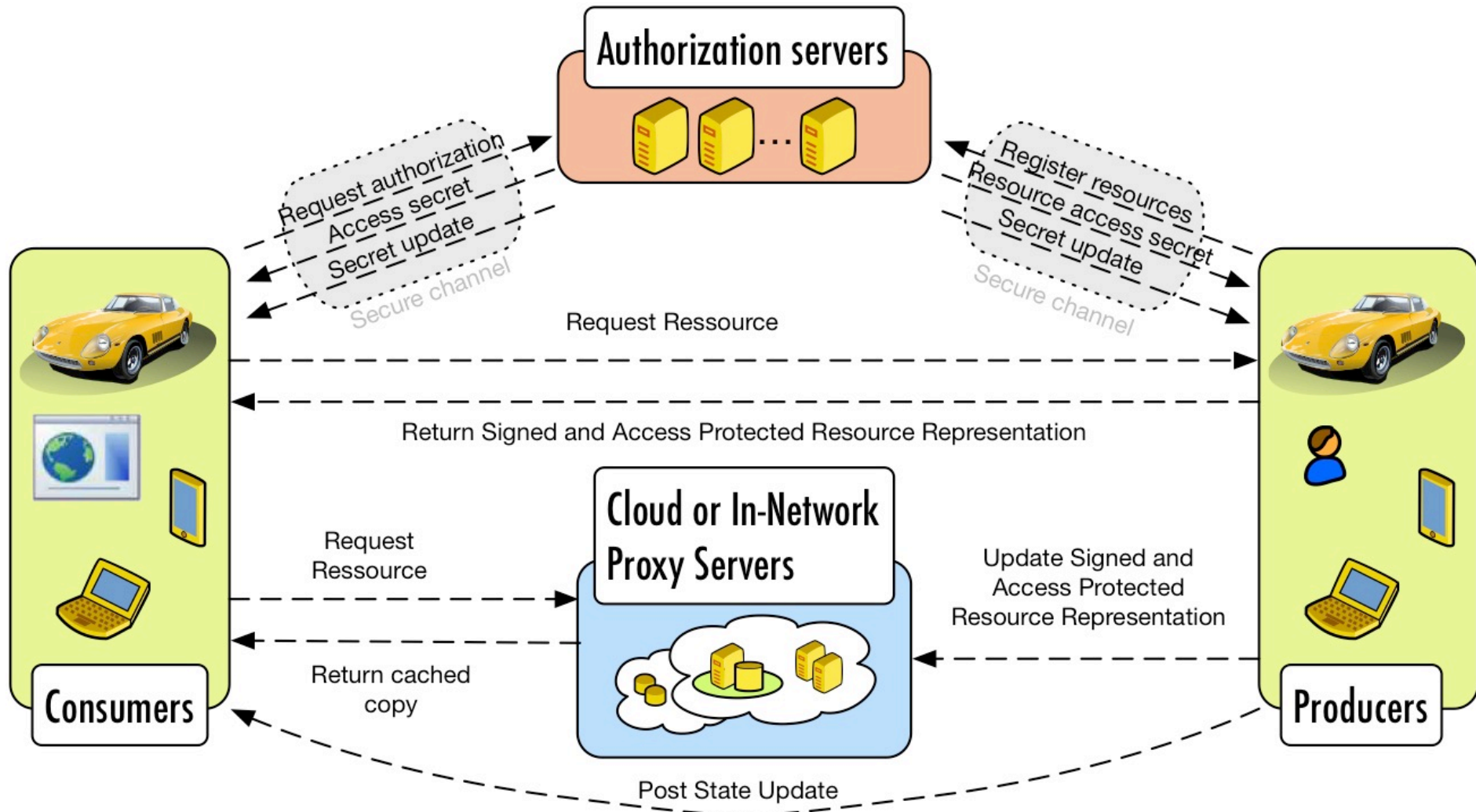
- **CSMA results in better packet delivery ratio**
- **Takes away duty cycle restrictions of ISM 868 band**

5G MTC

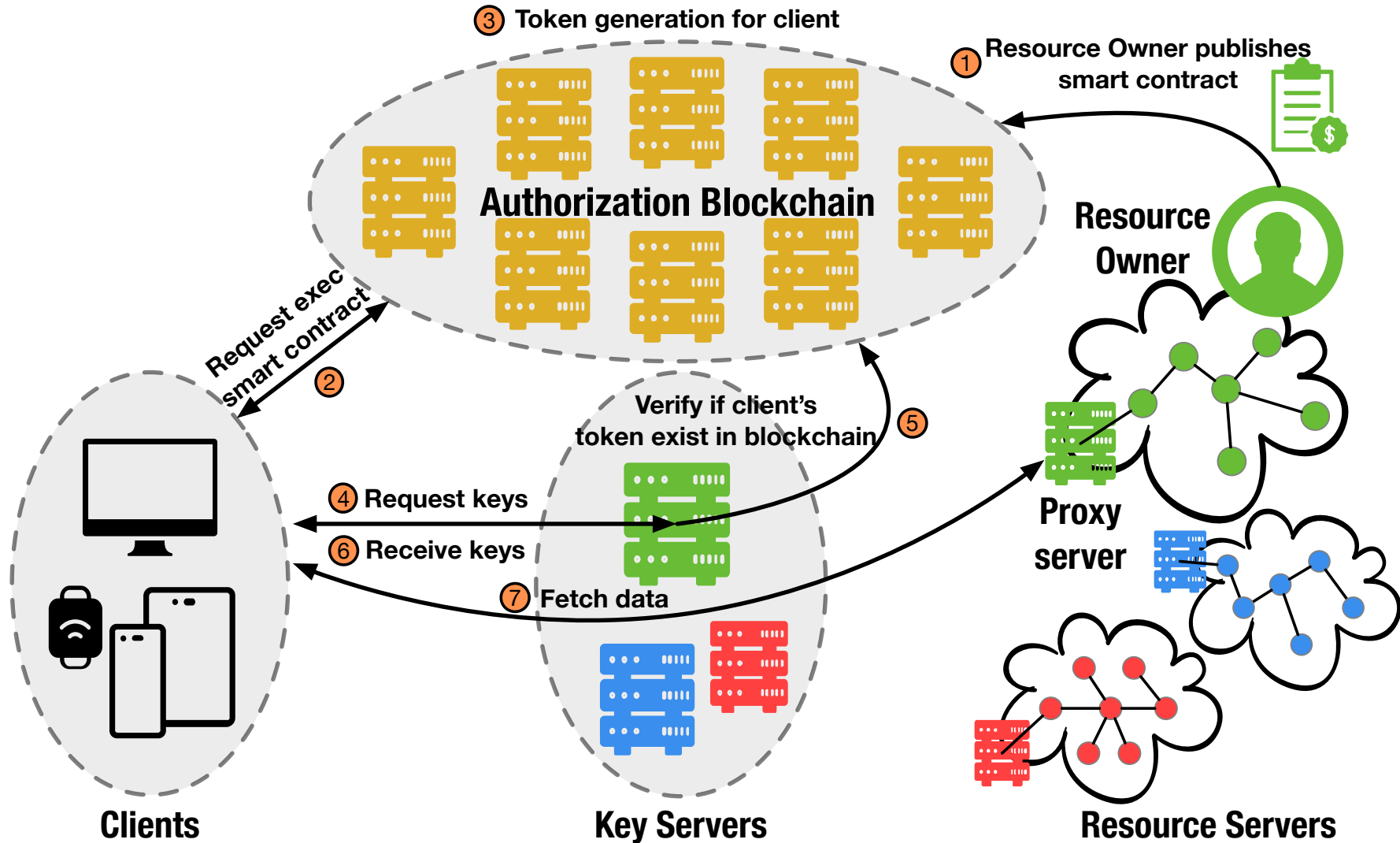
- **Need to find a suitable MAC**
 - fits 5G architecture
 - light signaling
 - low energy
 - massively scalable

IoT Security

IoT Object Security



IoT Object Security



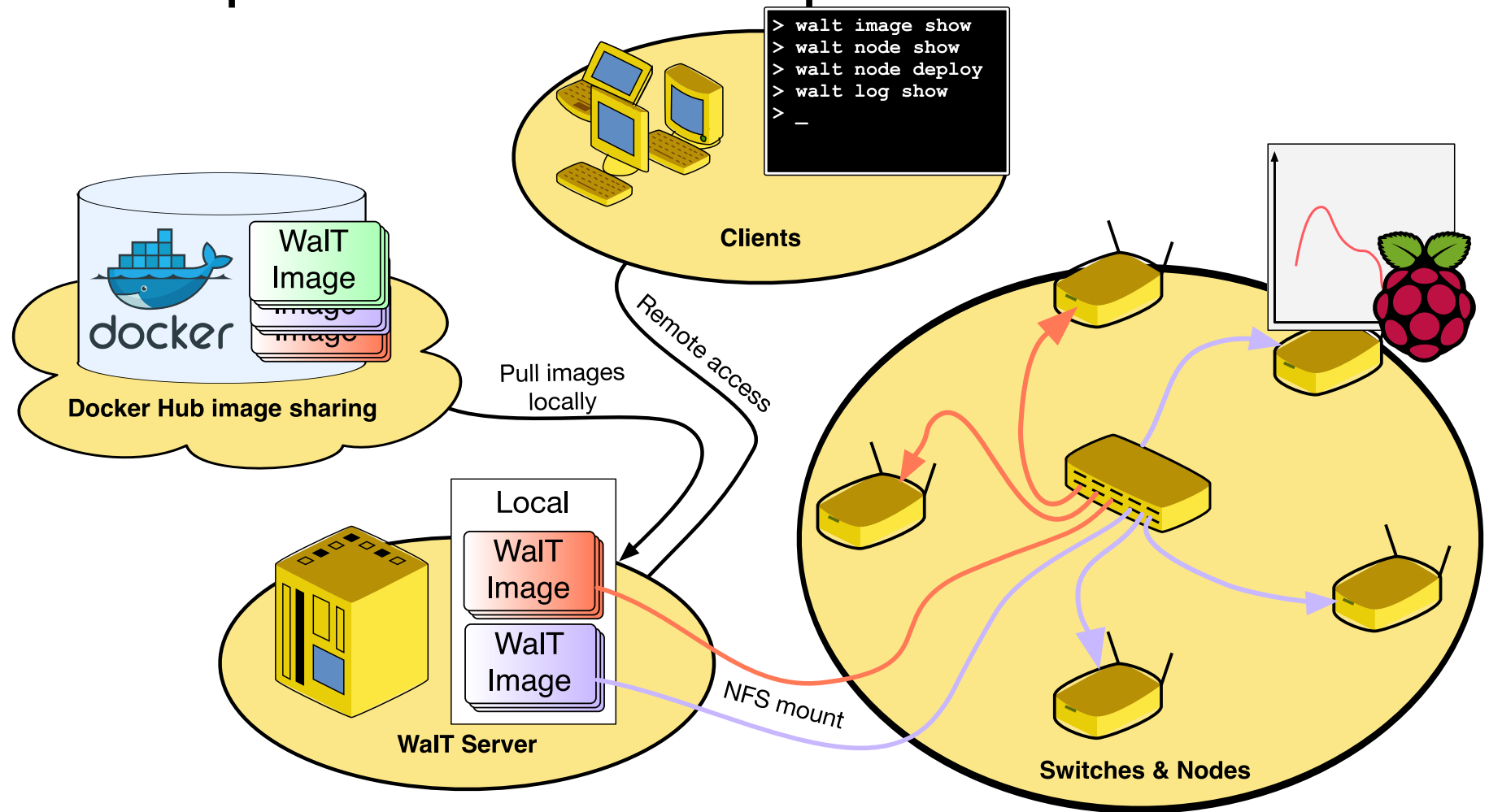
Reproducibility - WalT platform

Reproducibility

- **Validating new protocols for wireless networks is a challenging task**
 - simulations far from realistic conditions
- **Perform real-world experiments!**
- **Reproducibility - when an experiment can be reproduced under different conditions, while providing sufficiently similar results**
 - reproduce experiments, build upon, and compare their results with the previous work

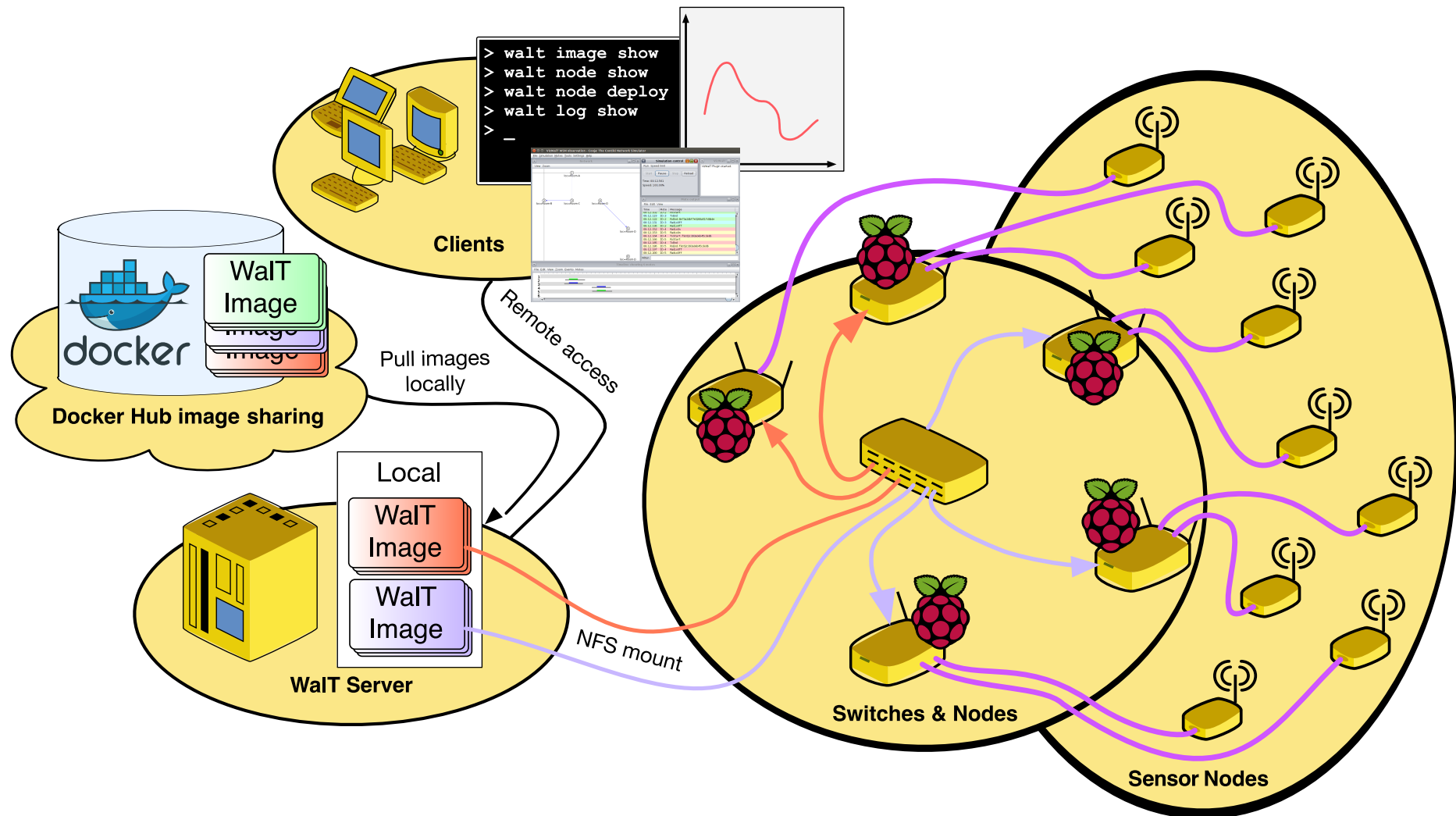
"I could not imagine much progress by reading only, without experimental facts and trials", M. Faraday

WaIT - reproducible platform to run reproducible experiments



• <http://wait.forge.imag.fr>

Use WaT to monitor Sensor Network



- **20 nodes deployed in LIG**
- **Used for various demos (in a backpack)**

Conclusions

- **Cellular vs. Capillary IoT**
 - several technologies available optimized for specific use cases
- **5G MTC**
 - a lot of current research
 - massively scalable MAC
 - low-latency MAC
- **Importance of experimentation**
 - reproducibility
 - <http://walt.forge.imag.fr>