How can ICN benefit IoT Protocols?

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"Research Activities and Future of EU/US/JP ICN Projects" Workshop
Tokyo, Japan, 30 Oct. 2015

i-CAN

POINT

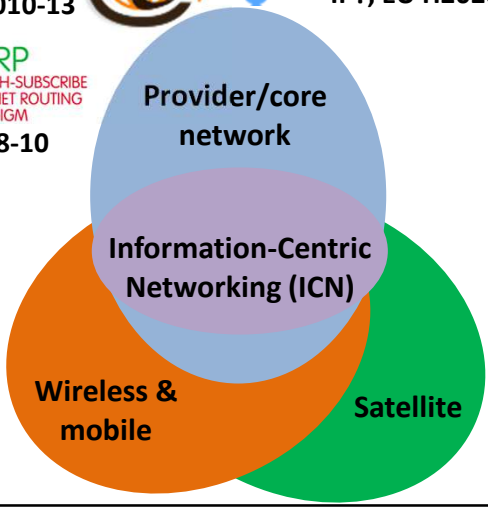
AUEB MMlab's ICN projects

Future Internet Award 2013
2010-13

PURSUIT

POINT
POINT: iP Over IcN- the betTer IP?, EU H2020, 2015-18

PSIRP
PUBLISH-SUBSCRIBE INTERNET ROUTING PARADIGM
2008-10



esa
φSAT
2011-13

SATNEx IV
2015-16

i-CAN
Information-Centric future mobile & wireless Access Networks, Greek Excellence, 2014-15

"That is the essence of science: ask an impertinent question, and you are on the way to a pertinent answer."

Jacob Bronowski

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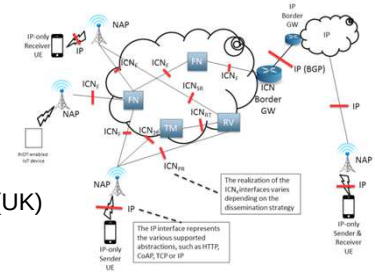
POINT: IP Over ICN - The Better IP?

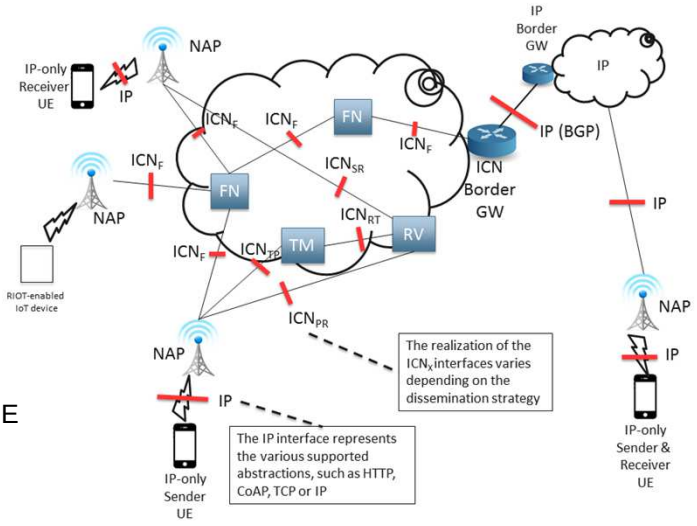
- Project
  - Duration: 1/1/2015-31/12/2017
  - Partners:
    - Aalto U (co-ordinator), ELL-I (FI)
    - Intracom Telecom, AUEB-RC (GR)
    - CTVC Ltd, Interdigital Europe, U Essex (UK)
    - RWTH Aachen (DE)
    - Primetel (CY)



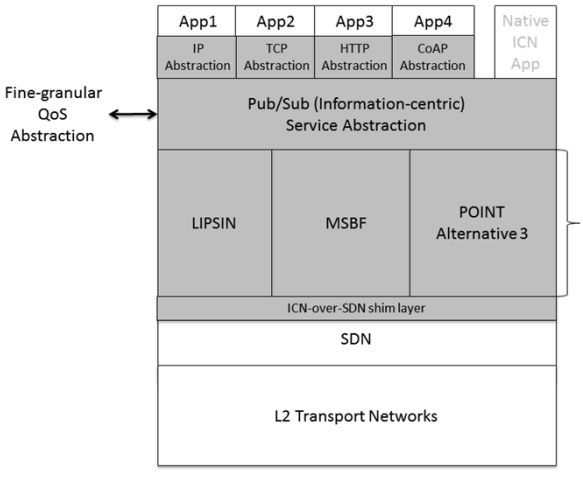
- Concept
  - Premise: IP apps can do better over ICN
    - Need to define what "better" means
  - Better utilisation in HTTP streaming scenarios
  - Better privacy of personal data and metadata
  - Better management of virtual network paths
  - Better (fairer) content distribution

POINT Domain

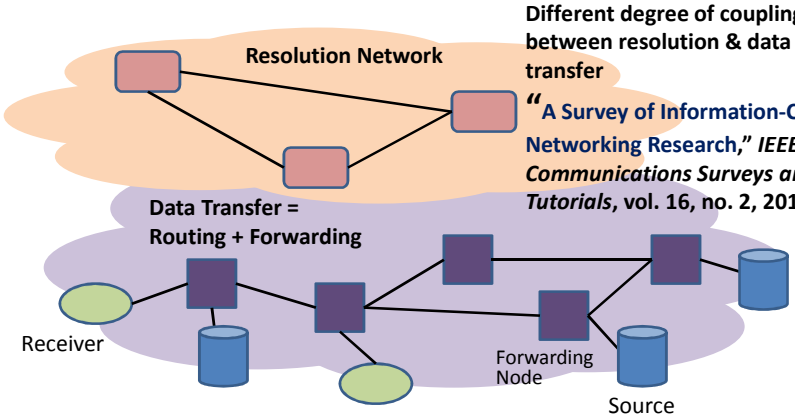
- Focus
  - 1 provider
  - UE: no changes (required)
  - ICN used internally in network
  - ICN could be exposed to UE



POINT layers



Basic Functions of ICN



Different degree of coupling between resolution & data transfer

"A Survey of Information-Centric Networking Research," *IEEE Communications Surveys and Tutorials*, vol. 16, no. 2, 2014.

- **Name resolution:** Match requests to content advertisements
- **Routing (topology formation):** Determine path from source (publisher) to receiver (subscriber)
- **Forwarding:** Transfer content from source to receiver

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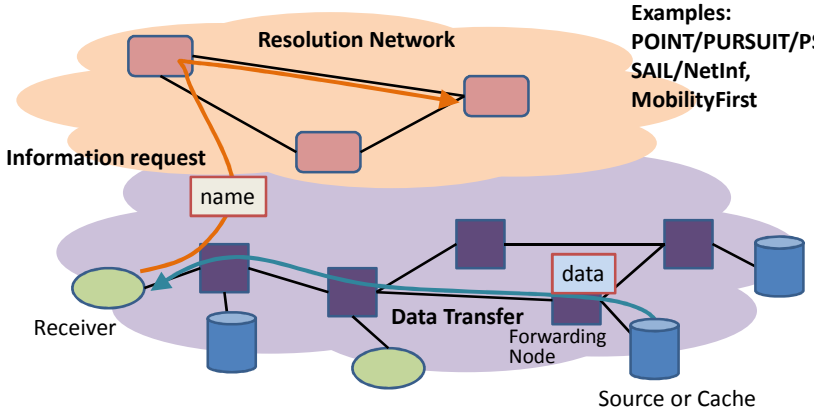
Decoupled Resolution & Data Transfer



Examples:
POINT/PURSUIT/PSIRP
SAIL/NetInf,
MobilityFirst

- Resolution function matches requests to sources or caches (in-network caches)
- Data path independent of request (control) path

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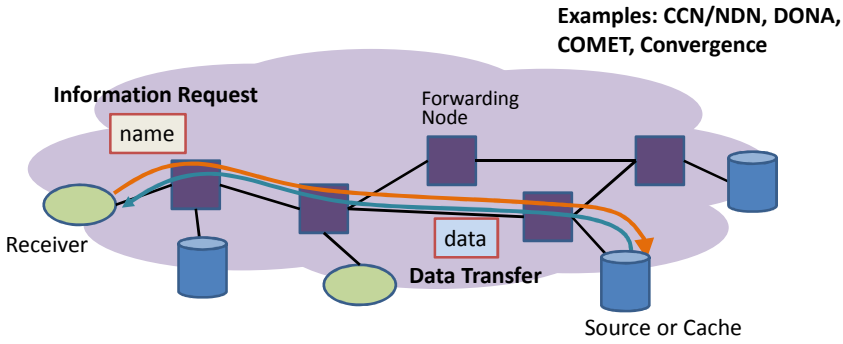
Coupled Resolution & Data Transfer



- Nodes route information requests to source or cache (in-network caching)
- Data path inverse of request (control) path

Tradeoffs from different coupling of Name Resolution & Data Transfer

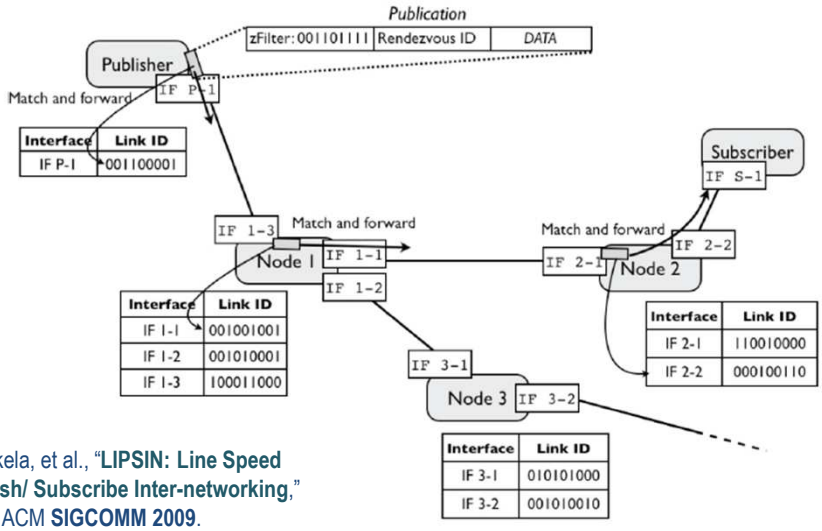
Coupled

- Data path reverse of request (control) path
- Aggregation of Interests as they are routed towards sources
- Easier to overcome short-live link disruptions through local routing mechanisms for requests
- No discrete resolution phase

Decoupled

- Can modify data transfer without modifying resolution function
- Support for advanced policies (e.g. QoS, interconnection)
  - Implemented by one function without affecting the other
- Exploitation of different paths for control & data (e.g. low-delay path for control and high bandwidth path for data)
- More choices for supporting source mobility

LIPSIN stateless multicast based on Bloom filters



P. Jokela, et al., "**LIPSIN: Line Speed Publish/ Subscribe Inter-networking**," Proc. ACM **SIGCOMM 2009**.

IoT protocols

- IoT protocols are **application layer, middleware, API**
  - **MQTT** (created by IBM 1999, OASIS standard 2014): pub/sub, centralized broker-based, hierarchical naming
  - **DDS – Data Distribution Service** (OMG standard 2004, recent version 2015): pub/sub, distributed, hierarchical naming
  - **CoAP** (IETF 2014): request/response, HTTP-based
  - Many more: **AMQP, XMPP,** etc
- ICN is a **networking** architecture
  - Unlike IoT protocols which are **application layer, middleware, API**

Goal of this presentation:

- ***Not*** to present new ICN architecture for IoT
- but "How ICN can ***benefit existing*** IoT protocols?"

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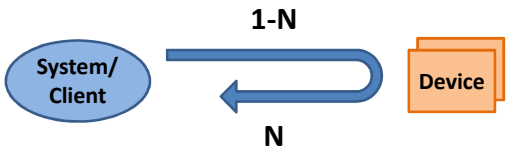
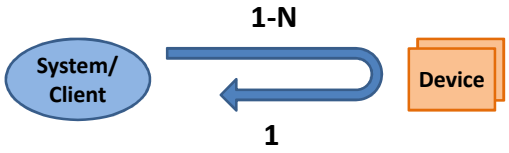
IoT communication mode: Pull

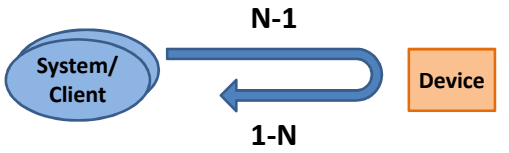
- Query many / response from many
  - Status/data retrieval



- Query many / response from any



- Many query one / response to many



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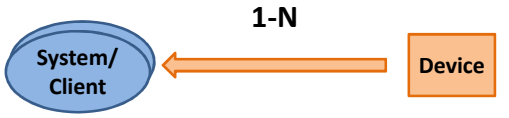
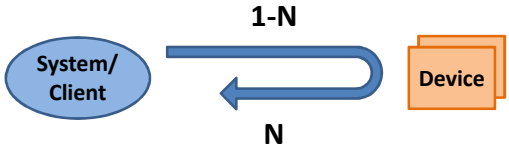
IoT communication mode: Push

- Push to many
  - Telemetry/notification



- Send command to many / response from many



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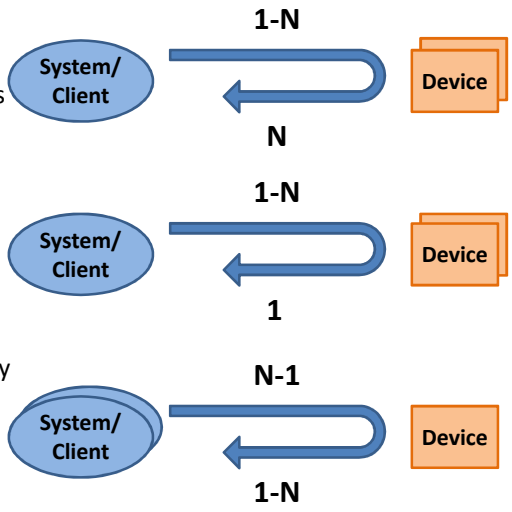
Pull patterns and IoT protocols

- Query many/response from many
  - CoAP: multiple requests or multicast request
  - MQTT/DDS: Two pub/sub pairs for each client, device pair; single or multiple query msgs, response topic in pub msg
- Query many/response from any
  - MQTT/DDS, CoAP: no specific support
- Many query one/response to many
  - CoAP: multiple requests, multicast reply
  - MQTT/DDS: multiple requests, one to many response



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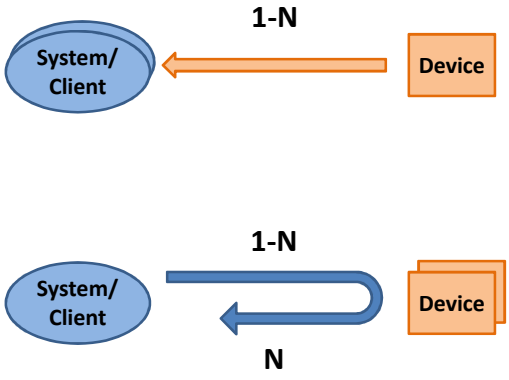
Push patterns and IoT protocols

- Send to many (unidirectional)
  - MQTT/DDS: native pub/sub
  - CoAP: Observer mode, multicast
- Send command to many & receive response
  - MQTT/DDS: Two pub/sub pairs for each client, device pair
  - CoAP: multiple msgs or multicast



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Communication patterns & IoT protocols

- Telemetry/notification push
  - MQTT/DDS: native **pub/sub** (with **persistent subscriptions**)
  - CoAP: req/reply with "observe" mode (≈ **persistent requests**)
- Query/response and command/response require **bi-directional communication**
  - CoAP: native request/reply
  - MQTT/DDS: two pub/sub pairs (for request and reply)
- **One-to-many communication** for queries/commands & responses
  - MQTT: **central broker**
  - CoAP & DDS: **multicast**
- **From Any communication**
  - No specific support

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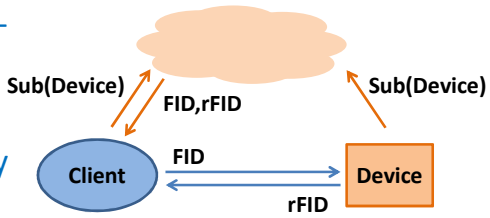
ICN **networking** features: Publish-Subscribe Internet (POINT, PURSUIT)

- Pub/sub exchange yields bi-directional forwarding IDs
  - ⇒ single pub/sub exchange can support request/reply



- LIPSIN stateless multicast using Bloom filters
  - ⇒ Group polling & push
  - ⇒ clients can *dynamically* form ad hoc groups

Hierarchical names & wildcards can't have same flexibility

(Device,FID) cached in client:

Device	FID
Bld1/Flr2/Rm1/Temp/1	FIDx
Bld1/Flr2/Rm2/Temp/2	FIDy
…	

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ICN **networking** features: CCN/NDN

- Identical Interests are aggregated

  ⇒ reduce network load when many clients request same Data
- Any copy of Data can satisfy Interest

  ⇒ native support for “From Any” communication
- Data multicasted to many requesters

Conclusion

- Some **IoT protocols** are **mature** and used extensively in **real products**
- IoT can be natively supported by ICN. But is this the **best strategy for ICN deployment?**
  - The Application/API layer model has similarities: pub/sub, request/reply, persistent subs/requests, …
- **How can ICN benefit IoT protocols?**
  - Main benefits are related to **networking features**
  - H2020 **POINT**: I**P** **O**ver **ICN** - **T**he Better IP?

Thank you!

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