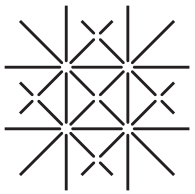
The Name of the Networking Game . . .

. . . is Term Rewriting

ICNRG interim, Paris, Sep 27, 2014

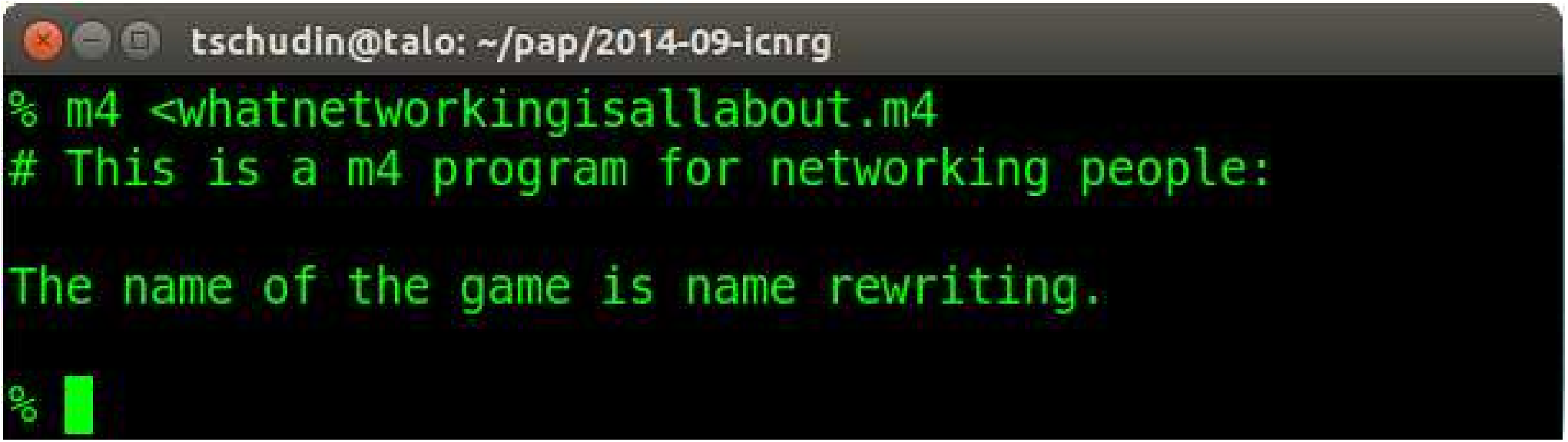
```
# This is a m4 program for networking people:
define(y,   `Y()me')dnl
define(X,   `g``'')dnl
define(x,   `n``'')dnl
define(Y,   `a')dnl

The x()y of the X()y is x()y rewriting.
```



Christian Tschudin, University of Basel

What Networking is all about; What this talk is all about



This talk is:

– an attempt to **draw a map** of ICN approaches, including named fcts

– not about λ-Calculus

Name Rewriting is Daily Networking Business

`parc.com`

↓

`omega.xerox.com`

↓

`13.1.64.95`

↓

`...`

(MAC address, VLAN port, SDN magic . . .)

Networking Protocols as **Term** Rewriting

Request/reply protocols (in a LAN), e.g. `ping alto.xerox.com`

```
<nodeA, src_ip, dest_name, request>
        | DNS
<nodeA, src_ip, dest_ip, request>
        | ARP
<nodeA, src_ip, dest_eth, request>
        | xfer
<nodeB, src_ip, request>
        | ICMP
<nodeB, src_ip, reply>
        | ARP, xfer
<nodeA, reply>
```

Rewriting Systems

Start with term — apply “rewriting rules” — start over

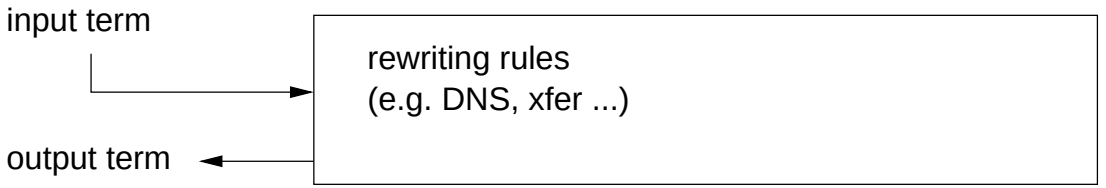
(as does m4)

$\exists$ Turing-complete rewriting systems, e.g. PCP

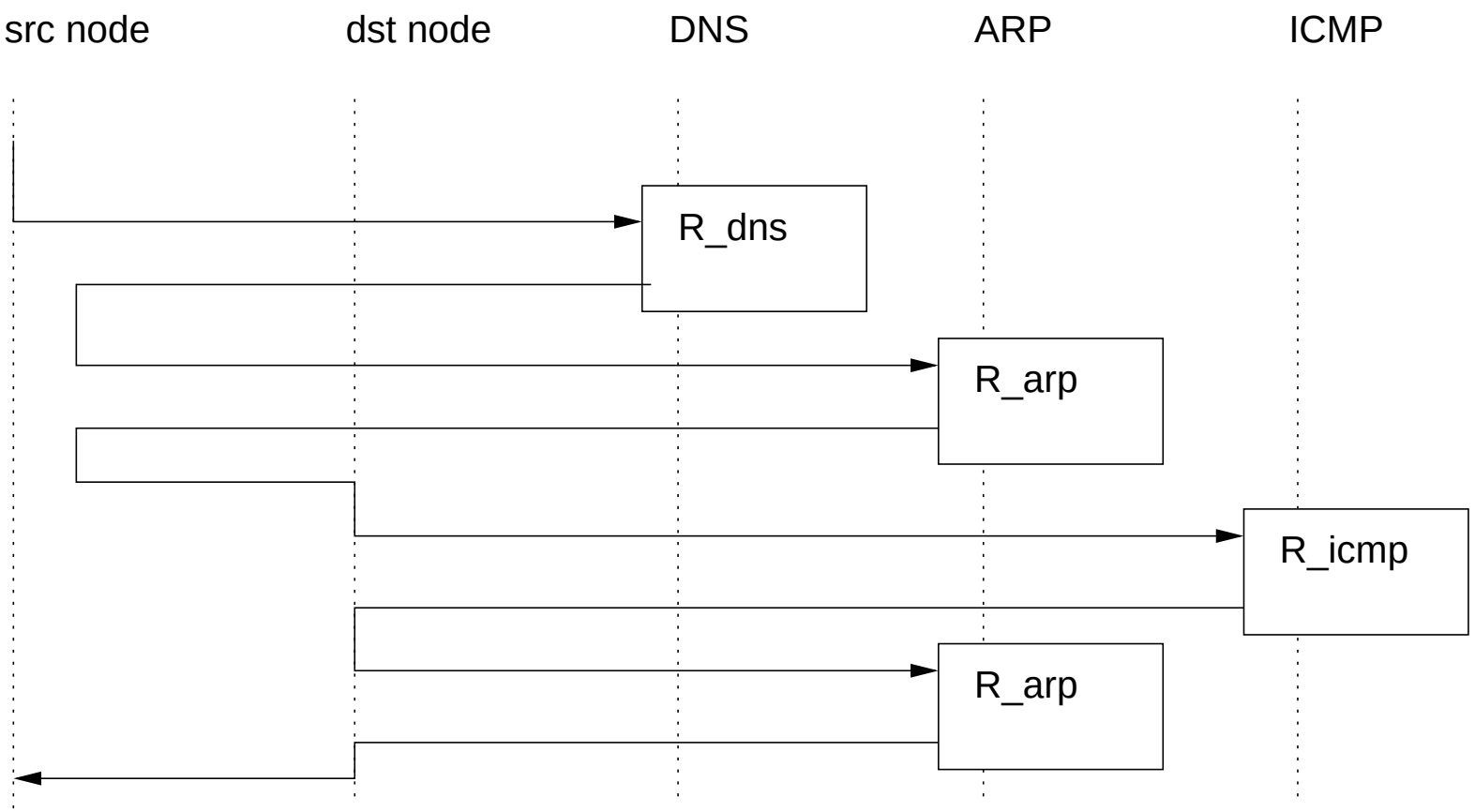
A graphic notation for rewriting rules in networking:

- DNS (a whole DB with replacement rules)
- ARP (substitution)
- transfer rules (bit shipping, including an alternate rule called “drop”)

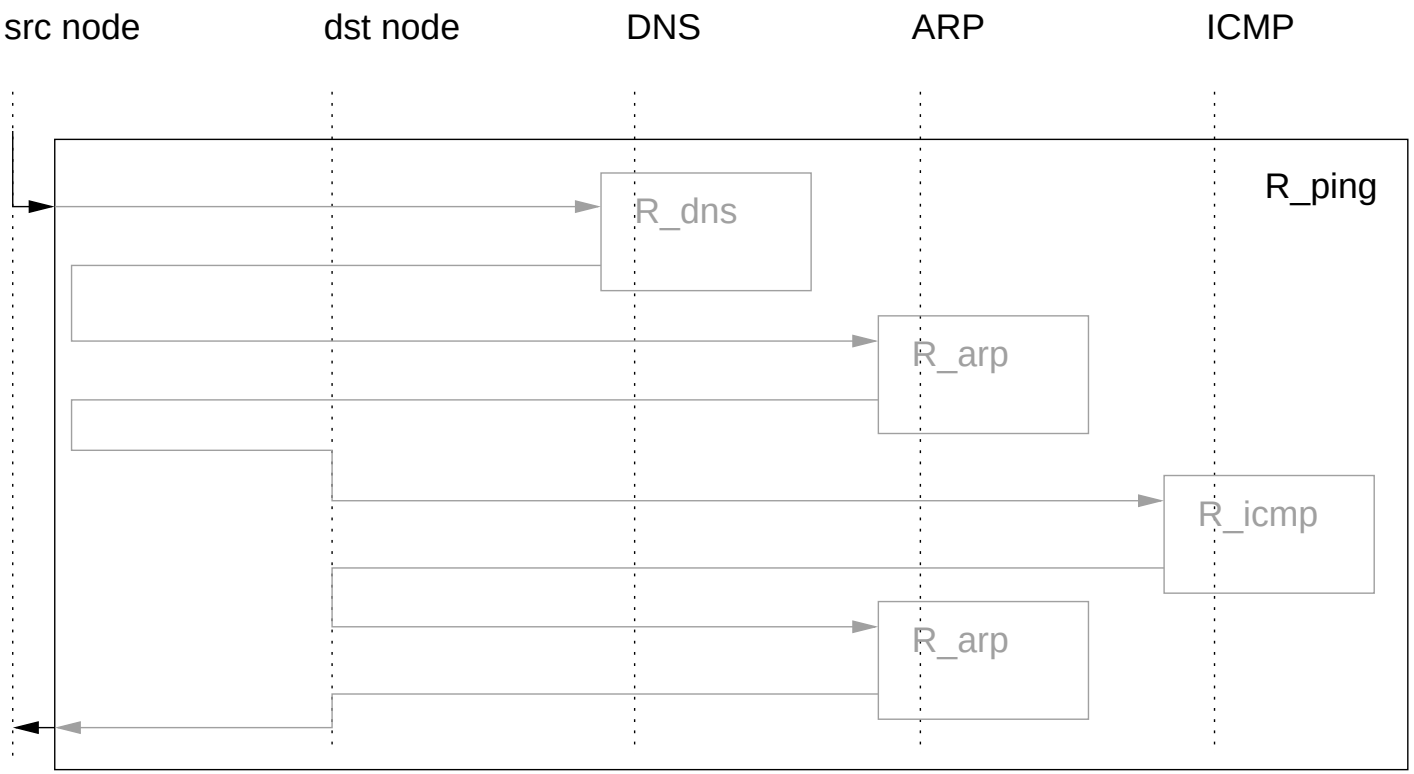
  etc.



Term Rewriting for Networking Protocols (graphic)



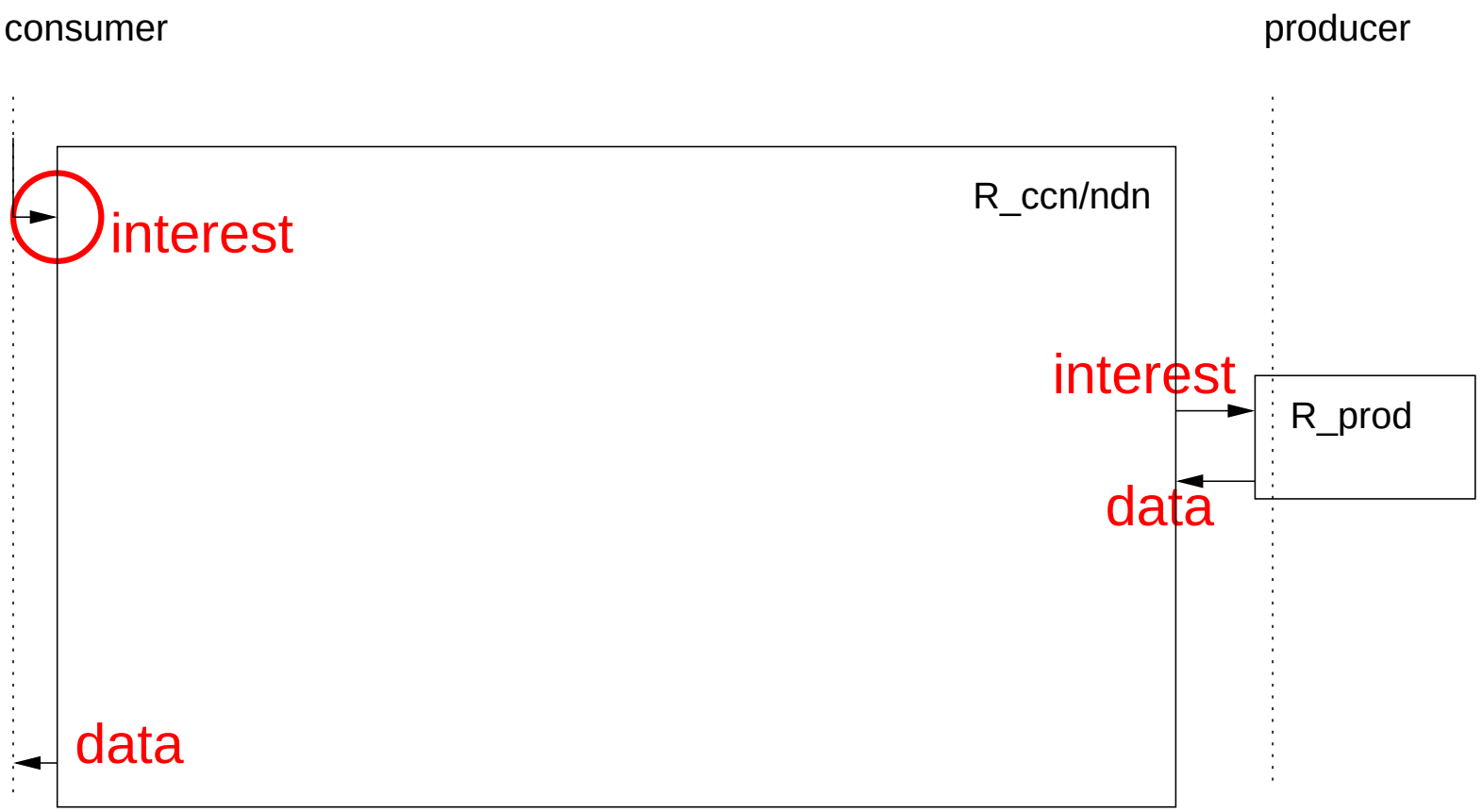
PING as a rewriting box – Hey, it's distributed computing!



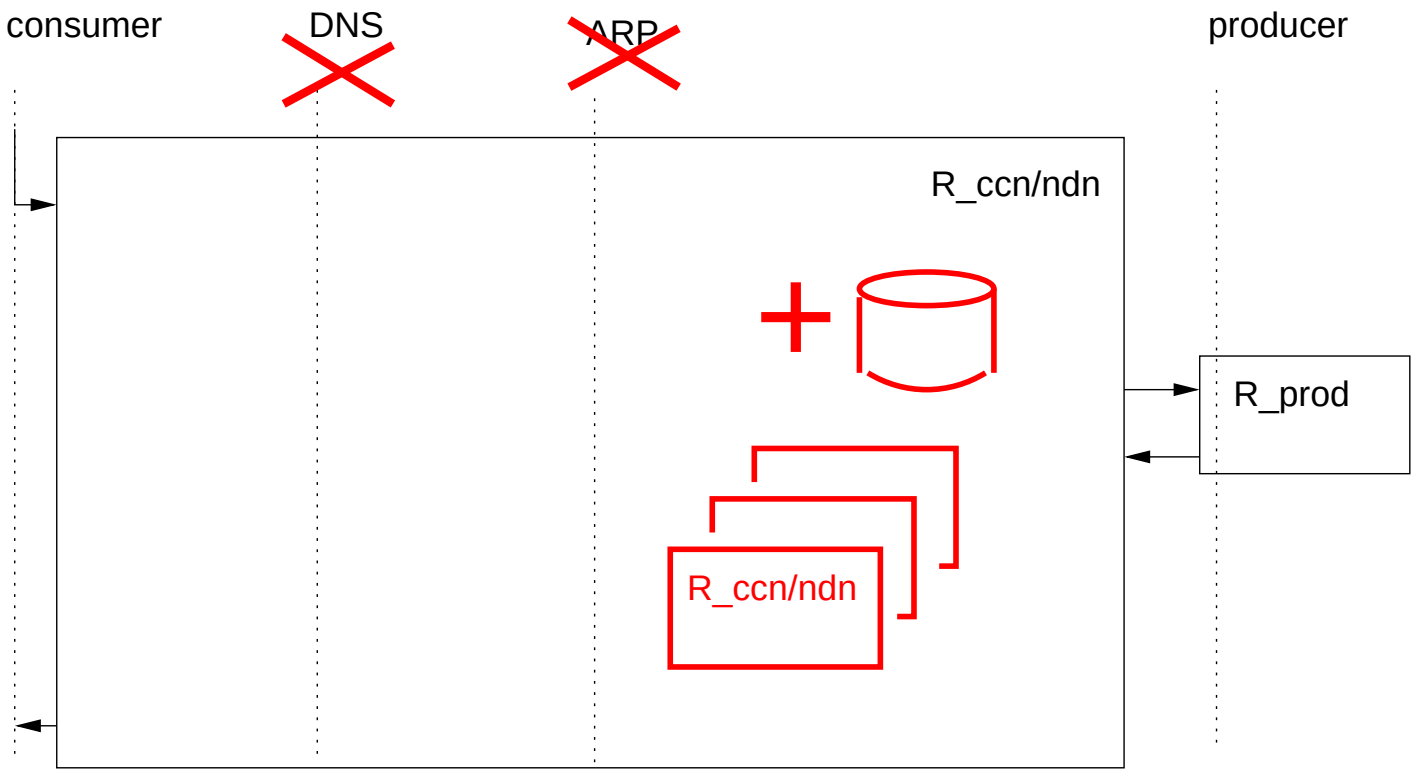
Potentially could capture (abstract, compose) all networking that way.

But: ∃ ugly sub-boxes (routing), little theory progress

CCN/NDN as Rewriting



Important contribution of CCN/NDN: self-similarity

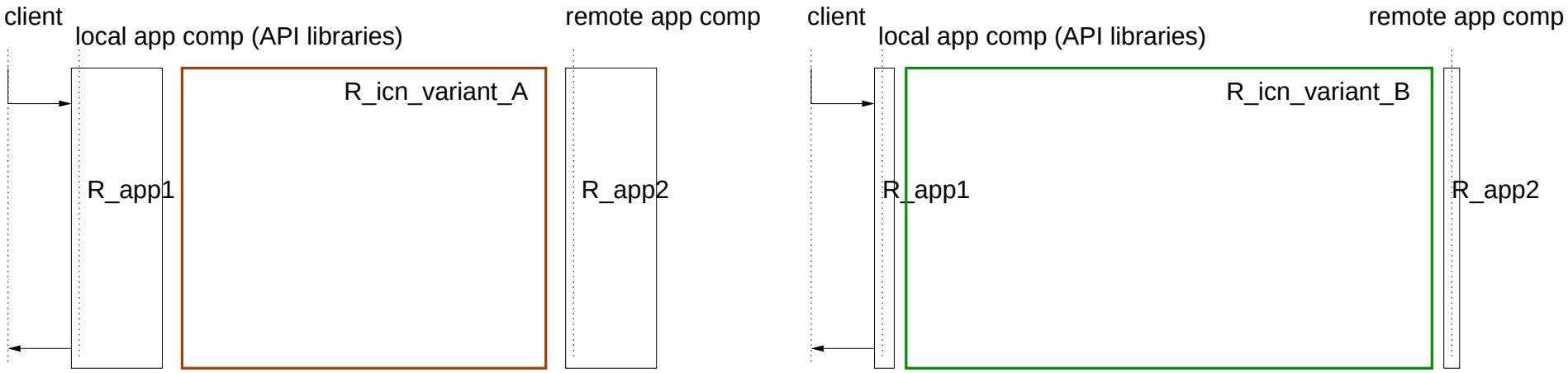


Usually mentioned first: in-network memory, no addresses, no ARP, etc

New (and important IMHO): unify service access and peering protocol
($\sim$ recursive boxes, “the-new-waist-as-a-fixpoint”)

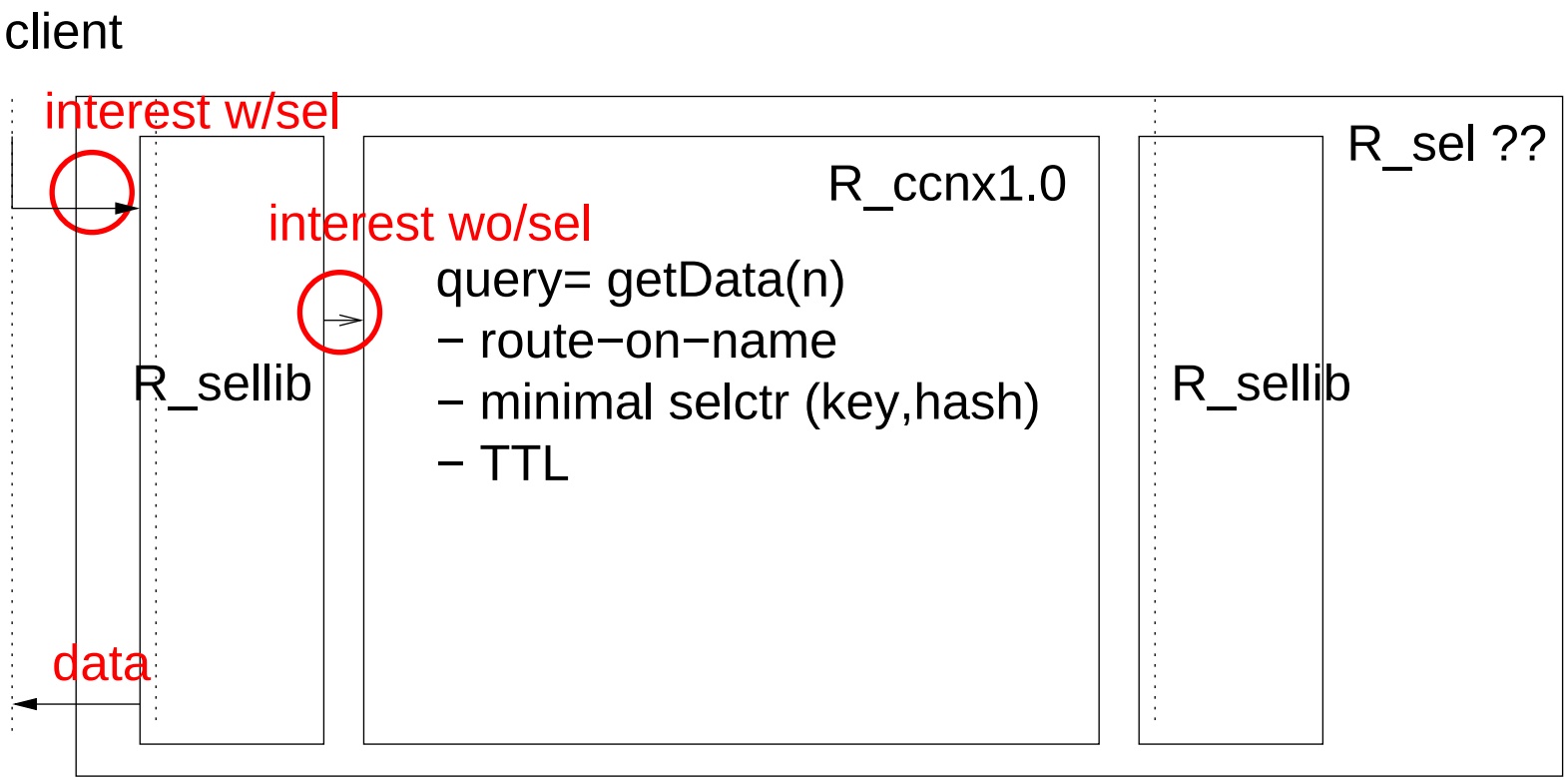
Network Rewriting Boxes and Applications

Service creation: composing application logic and an ICN networks (whose **expressiveness** might vary - this is our debate)



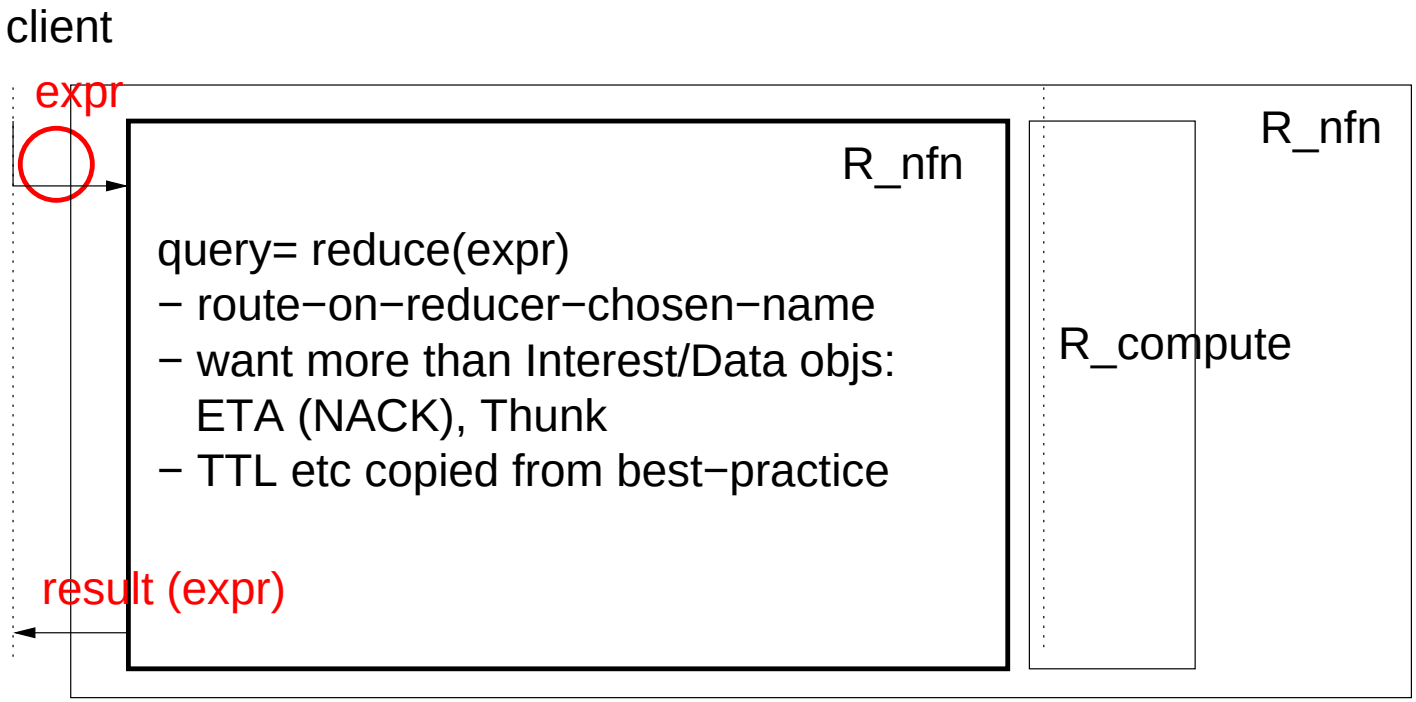
Spectrum from pure-transport to network-does-it-all, and in different ways: $\rightarrow$ **gallery**

Gallery: CCNx 1.0 and NDN



Bold claim (=non-trivial): R_{CCNx1}+$R_{SelectorLib}$ is equivalent to NDN.

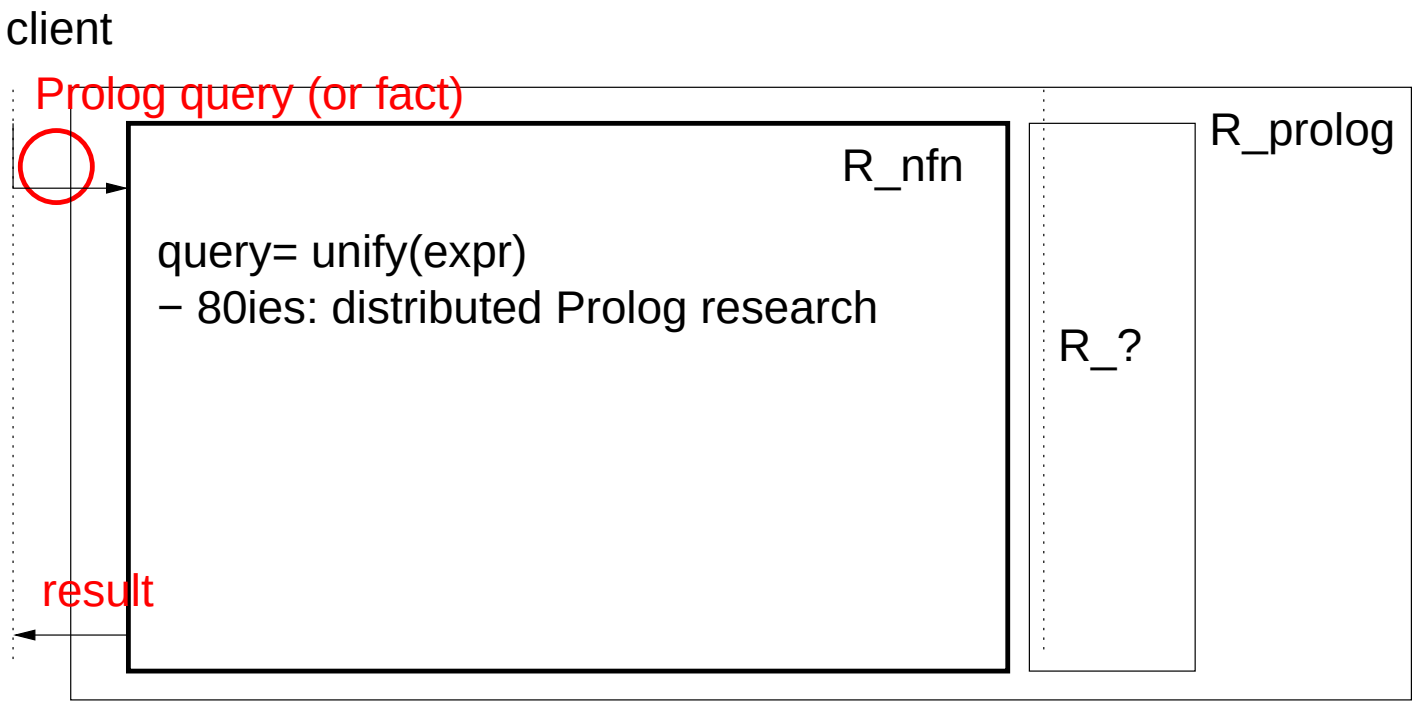
Gallery: Lambda-Calculus (NFN)



Non-trivial claims: R_nfn can emulate all ICNs; NFN is a fixpoint

Emulation argument: define `getFromNDN(NDNname)`, `getFromCCNx(CCNname)`, plus define name mangeling to map name spaces

Gallery: Prolog? – rewriting based on facts and rules



Powerful “unification” concept: `dns(name, X)`,
but also `dns(Y, 10.11.12.13)`

Restricted (finite) form of Prolog: **Datalog** ($\rightarrow$ NDlog papers, 2006-09)

Gallery: Service Chaining

see ACM ICN 2014 conf

M. Arumaithurai et al: *Exploiting ICN for flexible Management in Software-Defined Networks* (best paper award)

The “box” offers hop-by-hop rewriting of names

T. Braun: Service centric networking

Gallery: Database query languages

SQL, recursion, and (builtin) functions

Gallery: Descriptor based

more to explore

Concluding Observations, Questions

- Counter-intuitive:
  – NDN has **constant name-to-object binding**
  – Named-Function does repeated **rewriting of terms**.

  This is a key difference:
  named-data **has** implicit term "`getData(name)`"
  but this is not exposed, cannot be changed.

- Who will be layered on top of whom?
  NDN-over-CCN, NFN-over-NDN, ANY-over-NFN, . . .

- How to couple/peer different Named-Function styles
  and named-data transport networks?

Named Function Networking Agenda (Paris, 2014-09-27)

1. **Intro** to Named-Function-Networking (Data-on-Demand) (10')
2. **Other views**, projects, prototypes, plans? (15')

   NFN for NDN/CCNx, Service Centric Networking, NFN over NetInf?
   Cloud interfaces? NFN for IoT? Other? *NDNex, Sneak peek*

   What style? imperative vs declarative, Linda, DB semantics ...
3. **Requirements** for data-only suites (NDN, CCNx) (15')

   packet formats (expressions, thunks, results), NACK, ETA response,
   PIT-support, route announcements for servers
4. **Security** (10') – secure coupling, trusting results, (data) access filters
5. Future work: SIG or not? (5')