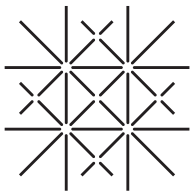
Named Function Networking

Service chaining, big picture, division of labor boundaries

IRTF ICNRG interim meeting, Boston, Jan 13+14, 2015



Christian Tschudin, University of Basel

Named Function Networking – Session overview

Part I – Service chaining (Dirk Kutscher)

Part II – Gentle/general introduction

Part III – NFN in one sentence
plus
* some rants about layers and engines
* packet format implications

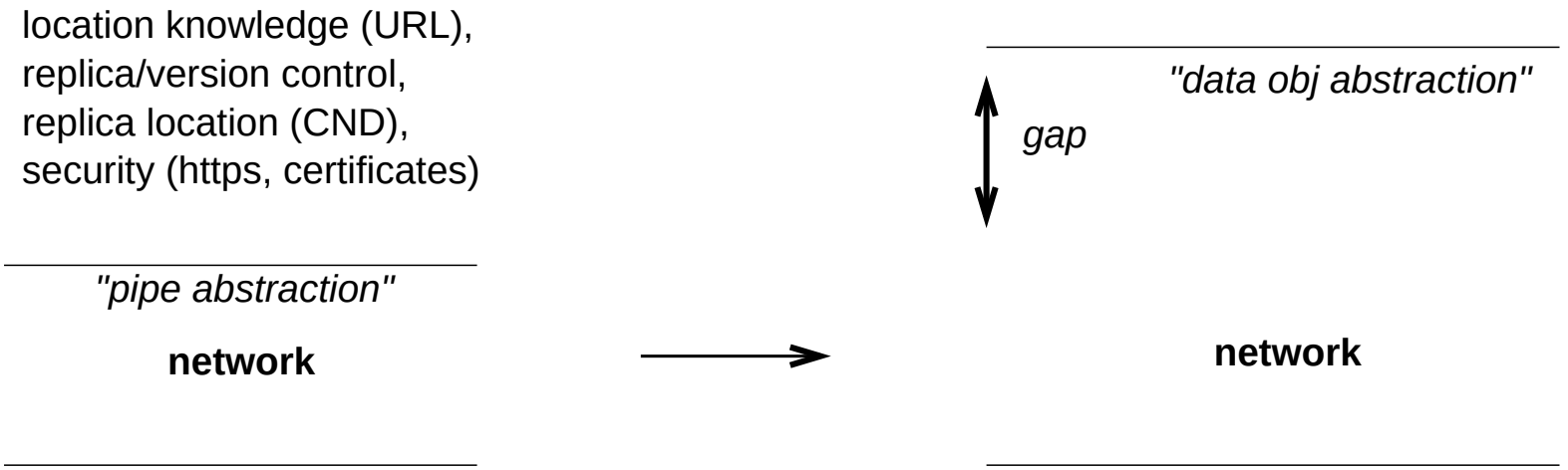
Part I

Service chaining (Dirk Kutscher)

Part II

Gentle/general introduction to NFN

Named-Data knowledge gap – Network intelligence



Raising the semantic level of the network API means: filling the gap

New answers necessary, different answers possible:

– redesign transport fabric to handle names

– new name-to-FIB mapping

– **“name space operations”** – from publish to exploration, mgmt and removal

From Named-Data to Named-Functions

- Raw data in abundance, but clients want cooked data . . .
  for which there are arbitrarily many recipies
- Examples:

```
/downScale( /this/video )
/getAverage( /sunShineHours/in/CA, 2014 )
/geoFence( /my/heart/rate, /my/gps/location, 10ft )
```

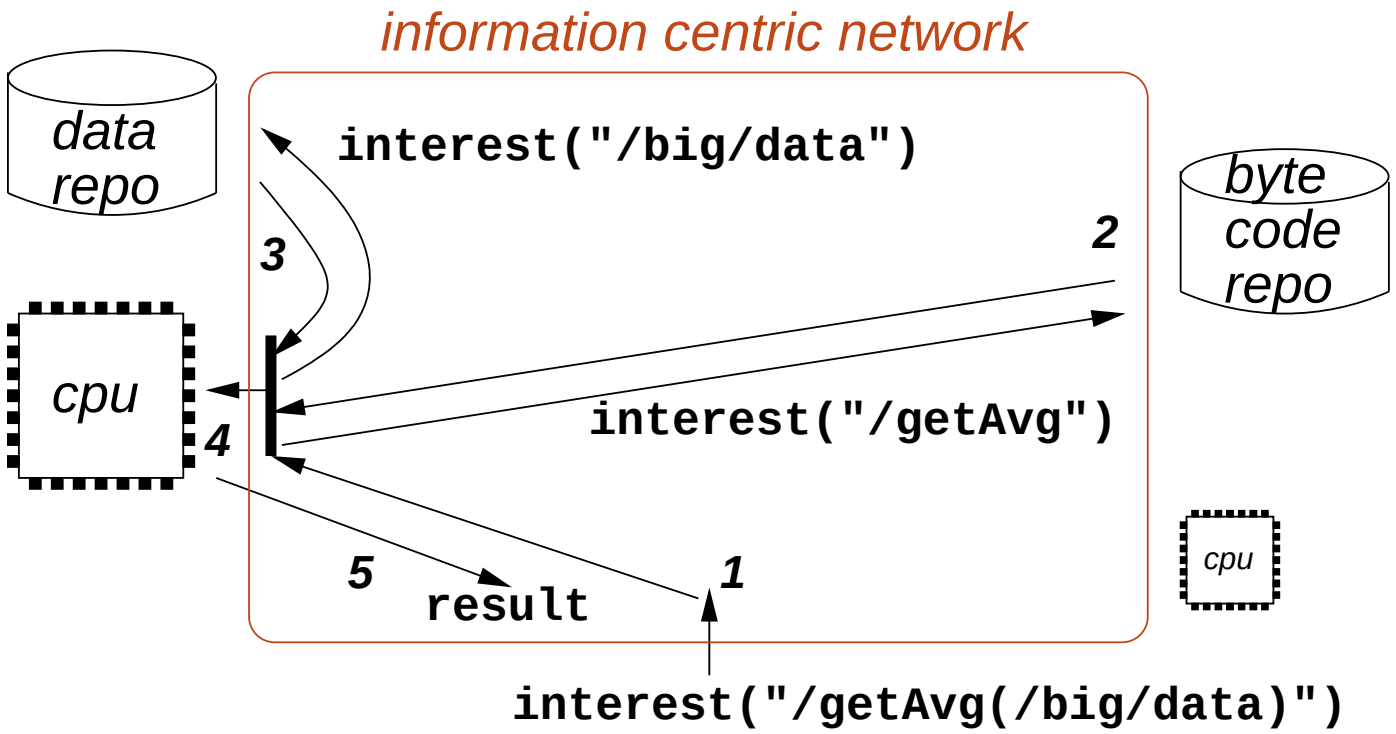
- The goal of Named Function Networking (NFN):
  – clients *name the desired result*, server-agnostically
  – network is in charge of finding execution places
  – network optimizes execution graph, caches the results

From Name-Lookup to Expression-Reduction

Realm	*Instances*	*Network Semantics*
Named Data *(access to data)*	"classic" ICN, key–value store, DNS	"name resolution" (= lookup)
Named Functions *(access to results)*	"new" ICN	"expression resolution" (= processing)

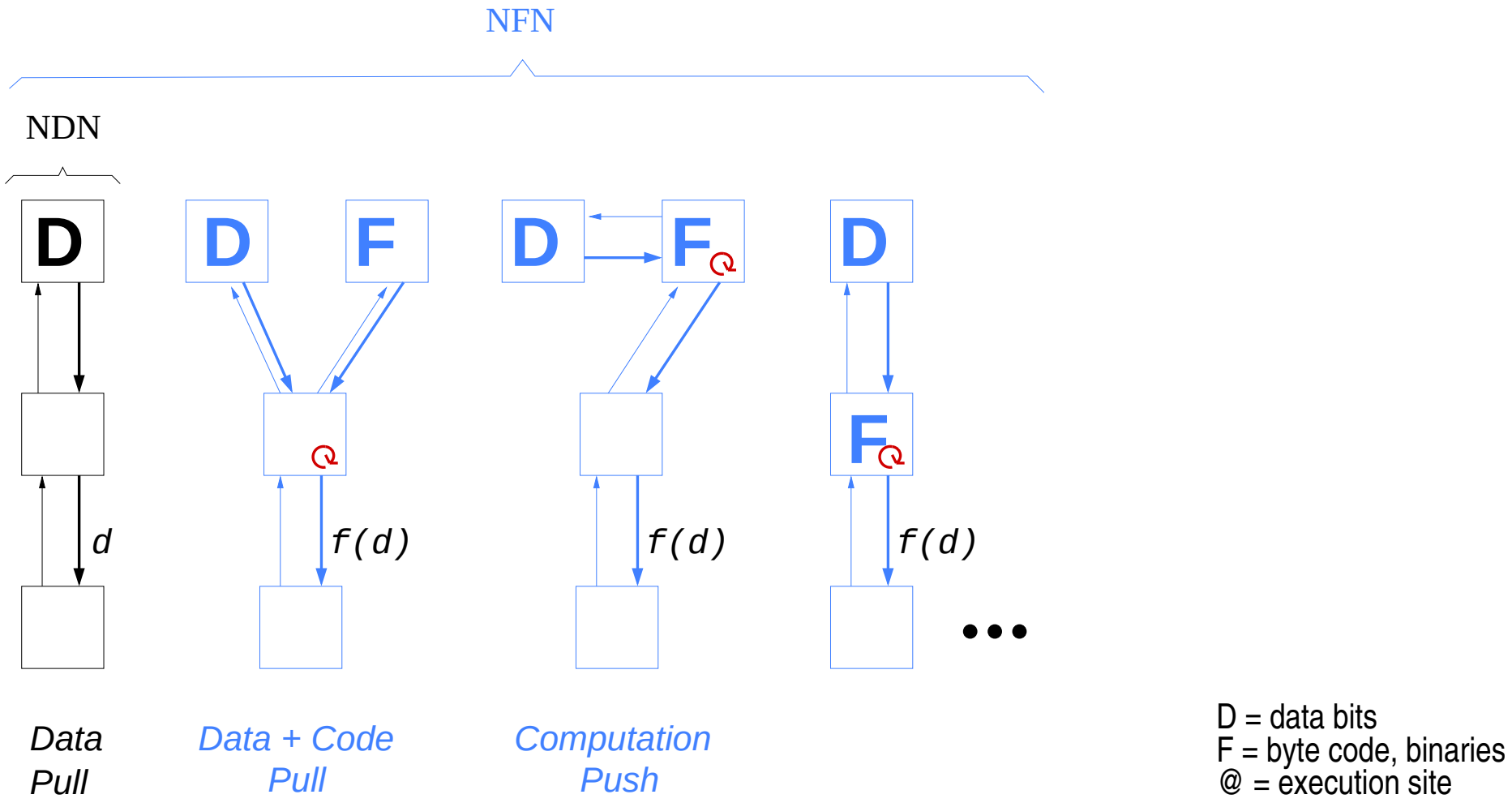
How: a) Locate data, fct and exec place, b) Run, c) Collect

REMOTE EVAL beats “download and process locally”: find a server close to the DB!



Network does **not** execute: NFN only orchestrates the computation by *juggling around names and triggering exec, later returning the collected result.*

“Routing”: Named-Data as a special NFN Case



Note: execution can, but *does not have to* be done in-network

Results as Names as Programs

"name the result . . . the network recognizes named results" **– how?**

- Lambda-expressions: most general approach, probably not your cup of tea

Results as Names as Programs

"name the result . . . the network recognizes named results" **– how?**

- Lambda-expressions: most general approach, probably not your cup of tea
- Other ways of expressing results. NFN enables choice:
  `/iFeelLucky( Hotel Sonesta Boston )`
  `/yahoo( Hotel Sonesta Boston )`
- NFN for network tasks:
  NFV `/kvsLookup( /DPI( /loadBalance( /name )))`
  IoT `/mapReduce(/sensors(/my/house, temp, 2014), /avg)`
  Mgmt `/keepInCS = /mapReduce(/topTenNames(/my/neighbor/CS), /sort)`
- NFN also for CCN/NDN semantics variety:
  `/rightMostChild( /a/node/name )`
  `/exists( /a/node/name )`

Results as Names as Programs

The search of the good “expression language” . . .

- exact match
- selective match
- . . .
- DB query languages
- Datalog
- intentional naming
- Prolog, λ expressions

. . . just started!

Part III

NFN in one sentence

– and some rants
– implications for packet formats, layering

Named Functions Networking in one sentence

A purposefully minimal definition:

Named Function Networking is an ICN style

where a requests carries at least two names

in order to be satisfied.

Examples where more than one name is needed

- Application – `compute(/name/of/fct, /name/of/arg)`

Examples where more than one name is needed

- Application – `compute(/name/of/fct, /name/of/arg)`
- Quantifiers – `retrieveAnyOf(/node/prefix, /pattern/star)`
  - also known as selectors (NDN)
  - also known as restrictions (CCNx' ObjHash, KeyID)
- Validation (based on references to keys = names)

In this "NFN intepretation" of CCN/NDN:

Where are the fct names?

– sometimes not choosable: functions are "named" in the specs

– for "real NFN": packet fmt to provide hooks for run-time-nameables

Rant slide: Stupid networks, redux?

"Extremist rant" on the ICNRG email list: Extreme contexts (high speed networking and the IoT) dominate the forwarding semantics discussion.

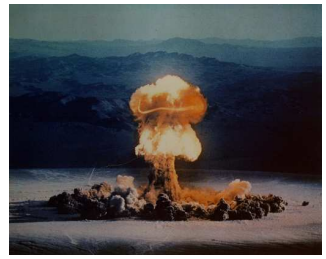
"The rise of stupid networks"
Isenberg's meme from 1997 – resurging?

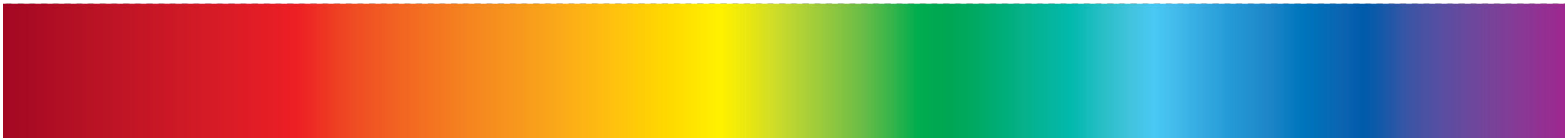
Contrarian view, from CES'2015 slides of Yu-Ting Yu, Qualcom, Mario Gerla et al.:

"ICNs are network architectures allowing the network to be aware of content semantics."

Concern that "in-network processing" becomes off-topic, is pushed to edge or app

A gradual spectrum – complementary



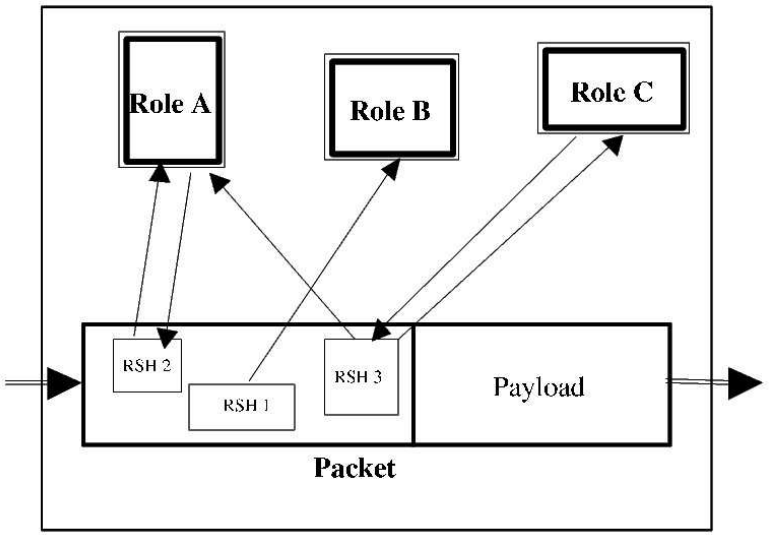


↑ stupid networks ↑ CCN ← “domesticated NFN” → λ calculus ↑

Division of labor, catenet model:

- High speed or IoT forwarding substrate is a base *level*, not a base *layer*:
  – envisage nodes with different “semantic height”
- Catenet model: heterogeneous forwarding domains, routers
  – Interest might hit a CS or not
  – Interest might hit a NFN-enabled node or not, . . .

A gradual spectrum – implications for packet fmts



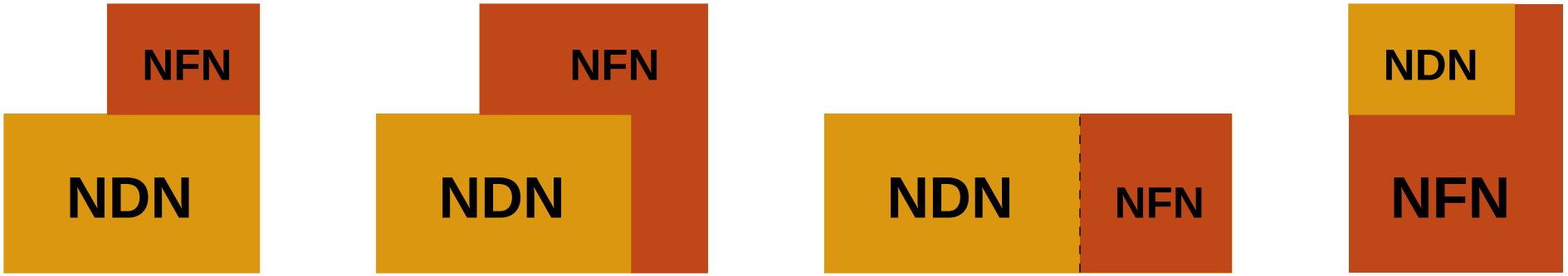
"Role-based architecture" (Braden/ Faber/Handly, Hotnets 2002):

provides header space for more than one "network function"

- Roles in CCN (would be nice if NDN could add this, too):
  Interest name – is for the forwarder, partly the CS
  Interest payload and opt header space – for the rest of us
- Not all role parameters are generated at the edge:
  – in-network generated hints, routing diversion, name rewriting
- Organize the Interest payload and/or opt header space

A gradual spectrum – implications for “layering”

CCN’s `exactCSlookup/PITcheck/LPMfwd` is a function,
NDN’s `LpmCSlookup/PITcheck/LPMfwd` is yet another function . . .



- Once you make these “namable”, NFN becomes the core
- ICN as assembly of several “engines”:
  – name space/expr engine (CCN style, pub/sub, Datalog, λ expr)
  – forwarder engine, policy engine, charging engine

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