T2TRG: Thing-to-Thing ~~proposed~~ Research Group

Thing-to-Thing RG (T2TRG)

Buenos Aires, AR

Summary meeting 2016-04-07

Prof. Dr.-Ing. Carsten Bormann

TZI – Universität Bremen

Note Well

- You may be recorded

- The IPR guidelines of the IETF apply:
  see **http://irtf.org/ipr** for details.

Administrivia (I)

- Pink Sheet
- Note-Takers
- Off-site (Jabber, Hangout?)
  - **xmpp:t2trg@jabber.ietf.org?join**
- Mailing List: **t2trg@irtf.org** — subscribe at: **https://www.ietf.org/mailman/listinfo/t2trg**
- Repo: **https://github.com/t2trg/2016-ietf95**

Agenda

- 16:20 Chairs RG overview, status
- 16:30 Ari RESTful design draft-keranen-t2trg-rest-iot
- 16:35 Mohit Secure bootstrapping survey draft-sarikaya-t2trg-sbootstrapping
- 16:45 Chairs Outreach, cooperation
- 16:51 Matthias Interaction models, hypermedia controls
- 17:03 Chairs Schema interoperability: call for contributions
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T2TRG scope & goals

- Open research issues in turning a true "Internet of Things" into reality
  - Internet where low-resource nodes ("things", "constrained nodes") can communicate among themselves and with the wider Internet
- Focus on issues with opportunities for IETF standardization
  - Start at the IP adaptation layer
  - End at the application layer with architectures and APIs for communicating and making data and management functions, including security

Done so far

- Multiple meetings before official chartering; co-located with IETF meetings and with W3C
- 2016: RG meeting at Nice co-located with W3C, and at San Jose co-located with IAB IoTSI WS
- Three RG deliverable documents in progress on REST and security (present two today)
- Outreach (e.g. orgs like OCF and Bluetooth SIG)

Where are we going

- Work on RG deliverables and outreach continues
- Future meetings co-located with good research venues (2017)
  - Meetings co-located with open source activity
    - Planning to start with RIOT summit in July 2016
  - Benchmark/reference scenarios
    - Initial discussion in various drafts and slides
    - More elaborate documentation by end of 2016

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RESTful Design for Internet of Things Systems

draft-keranen-t2trg-rest-iot-01

Ari Keränen <ari.keranen@ericsson.com>
with Matthias Kovatsch & Klaus Hartke

T2TRG @ IETF95

Goal of the Document

- “Guidance for designing IoT systems that follow the principles of the REST architectural style”
- Collect terminology
- Key information + pointers to details
- With IoT focus in examples etc.
- … while keeping it quick and easy to read

Where we are now

- -01 out
  - More terminology
  - Clarified idempotency and application state
  - What's different with IoT (data formats, interaction patterns, etc.)
- Remaining key topics including
  - Resource and media type design
  - Hypermedia-driven applications
  - Design patterns

Read/Comment/Spread the <3

- draft-keranen-t2trg-rest-iot-01
- Reviews and comments very welcome
- What would you like to see info about?
- Make other orgs aware of this

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Secure IoT Bootstrapping: A Survey

draft-sarikaya-t2trg-sbootstrapping-00

Behcet Sarikaya, Yizhou Li,
Mohit Sethi, Robert Cragie

Secure Bootstrapping

- What is bootstrapping and what is security bootstrapping?
  - Many definitions out there

- "it is the process by which a thing/device/smart object in an IoT network securely becomes operational at a given location and point of time."

- Possible goals of secure bootstrapping:
  - Identity: authentication of a pre-established identity vs. creation of a new identity
  - Authorization for network access, incl. configuration of communication parameters
  - Registration or joining a domain or group
  - Pairing with a specific node, or connecting to a cloud service

- This definition is broad on purpose since the term IoT itself represents a very diverse spectrum of applications
  - pairing of phones over bluetooth to exchange files, and
  - securely connecting IEEE 802.15.4 sensors factory to the backend both require some form of secure bootstrapping

Managed methods

- Pre-established trust relations and authentication credentials
- Centralized or federated
- Examples:
  - AAA / Extensible Authentication Protocol (EAP)
  - Generic Bootstrapping Architecture (GBA) with SIM
  - Open Mobile Alliance (OMA) Light-weight M2M:
    - Factory Bootstrap, Bootstrap from Smartcard, Client Initiated, Bootstrap
    - Server Initiated Bootstrap
  - Kerberos
  - Vendor certificates

P2P / ad-hoc methods

- No pre-established credentials
- Out-of-band channel used for distributing or confirming keys
  - Typically Diffie-Hellman exchange + MitM prevented with OOB communication
- Examples:
  - Bluetooth simple pairing
  - Wi-Fi protected setup
  - EAP-NOOB (out-of-band authentication for EAP)
  - Magic wand, e.g. commissioning tool in I-D.kumar-6lo-selective-bootstrap

Opportunistic / leap-of-faith methods

- Continuity of identity or connection, rather than initial authentication
- Some methods assume that the attacker is not present at the inititial setup
- Examples:
  - SEND and CGA
  - WPS push button
  - SSH, gmail, Facebook

Hybrid methods

- Most deployed methods are hybrid:
  - Components from both managed and ad-hoc methods
  - E.g. central management after ad-hoc registration
- Categorization is not always easy or clear

- Choice of bootstrapping method depends heavily on the business case:
  - What third parties available?
  - Who wants to retain control or avoid work?
  - Manufacturer/vendor, system admin, user, fully ad-hoc

Secure Bootstrapping

- Why we need a survey:
  - Learn the design assumptions and trade-offs
  - NOT produce a 100 page document
  - Help developers choose what option is suitable.
  - End-of-life and re-bootstrapping are complex:

    https://www.iab.org/wp-content/IAB-uploads/2016/03/draft-farrell-iotsi-00.txt

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Outreach & Cooperation

- Objective: Mutual Education with IoT SDOs
- Make sure that
  - SDO people know how to interact with IETF
  - SDO people know about IETF products
  - v.v.

Outreach & Cooperation

- **Ongoing**: joint meetings with W3C IG Web of Things (WoT)
- **Once** (so far): Joint meeting with Open Connectivity Foundation (OCF); increasing involvement.
- **Starting**: First activities with Bluetooth SIG
- **Future**:
  - Other relevant orgs (which?)
  - Pull in relevant academia
  - Interact with open source activities

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Semantic Interoperability Requires Self-describing Interaction Models

IRTF T2TRG Activity Report, IETF 95, Buenos Aires, AR

Matthias Kovatsch (matthias.kovatsch@siemens.com)

Information Model for Interoperability

- Make use of data produced by IoT devices
- Well understood that data must be meaningful

→ About the “what”

- Domain-specific requirements have led to multiple consortia
- Each consortium has defined their own data model
- Inferred meta model could help to bridge between data models

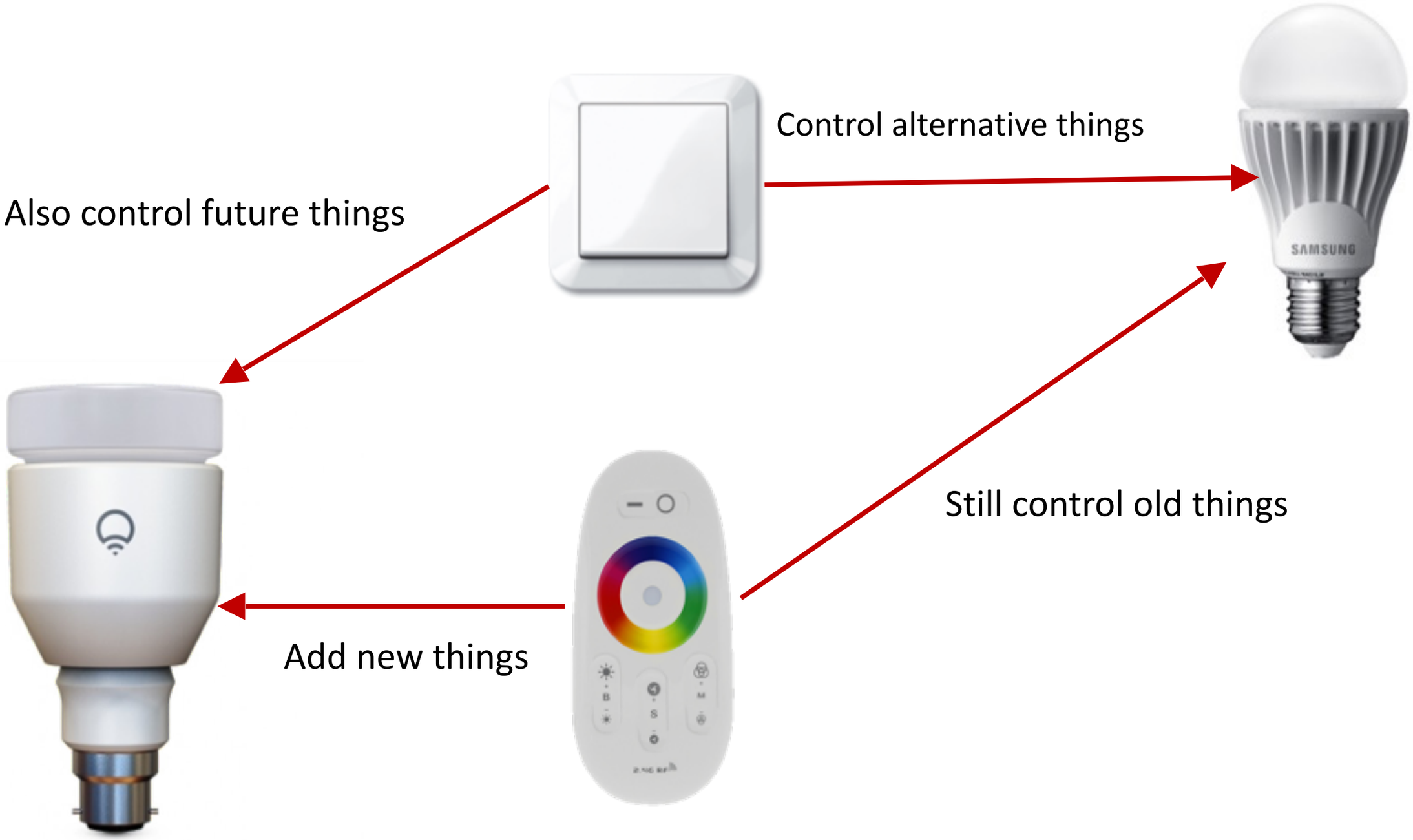
Interaction Model for Interoperability

- Machine-to-machine communication
- Make APIs machine-understandable

→ About the “how”

- Integration of descriptions on the server side is straight-forward
- Consumption on the client side is challenging
- Missing abstractions have led to hard-coded clients

Handling Change



Semantic Interoperability

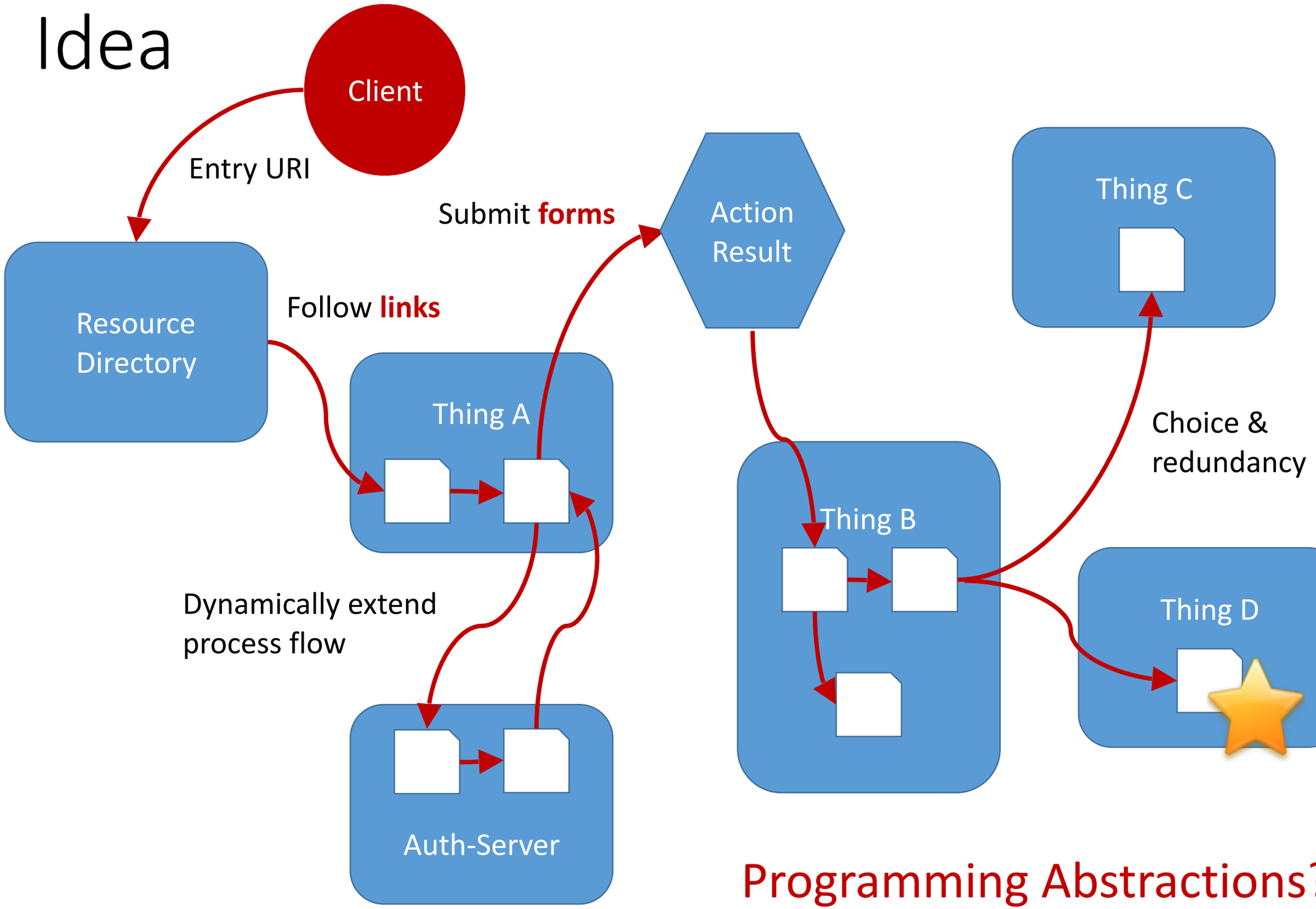
- Information model
  - Describing the exchanged information → vocabulary
  - Must allow for linking/bridging data models from different domains
  - W3C WoT: Semantic model such as RDF
- Interaction model
  - Describing the possible interactions → vocabulary
  - Must allow for change and diversity
  - T2TRG: Hypermedia-driven applications (HATEOAS)

T2TRG: Interaction Model with Hypermedia Controls

- Hypermedia As The Engine Of Application State (HATEOAS)

- Composition of multiple resources models things
- Atomic interaction steps (request-response) shape processes
- Links and forms describe how requests must be formulated
- Relation vocabulary attaches meaning (shared a priori)
- Publication of links and forms allows for change (shared at runtime)

Idea



Programming Abstractions?

CoRAL

(https://tools.ietf.org/html/draft-hartke-t2trg-coral)

The Web link (in RFC 5988 syntax):

```
<coap://example.com:5683/info/tos>
;rel=terms-of-service;type=text/plain
```

is serialized in CoRAL as follows:

```
[ /abs_link/             0,
  /terms-of-service/ 64,
  [ /format/              3, 0 /text//plain/,
    /href.scheme/         4, "coap",
    /href.host.name/      6, "example.com",
    /href.port/          11, 5683,
    /href.path/          12, "info",
    /href.path/          12, "tos"
  ]
]
```

Summary

- Semantic Interoperability
  - Information model ← W3C WoT IG/WG
  - Interaction model → hypermedia-driven applications
- Scenarios
  - Reference scenario → requirements and challenges
  - PlugREST scenario → prototyping and interoperability testing
- Building Blocks
  - Machine-understandable links and forms
  - Representation formats (hypermedia) for IoT applications
  - Guidelines for programming abstractions

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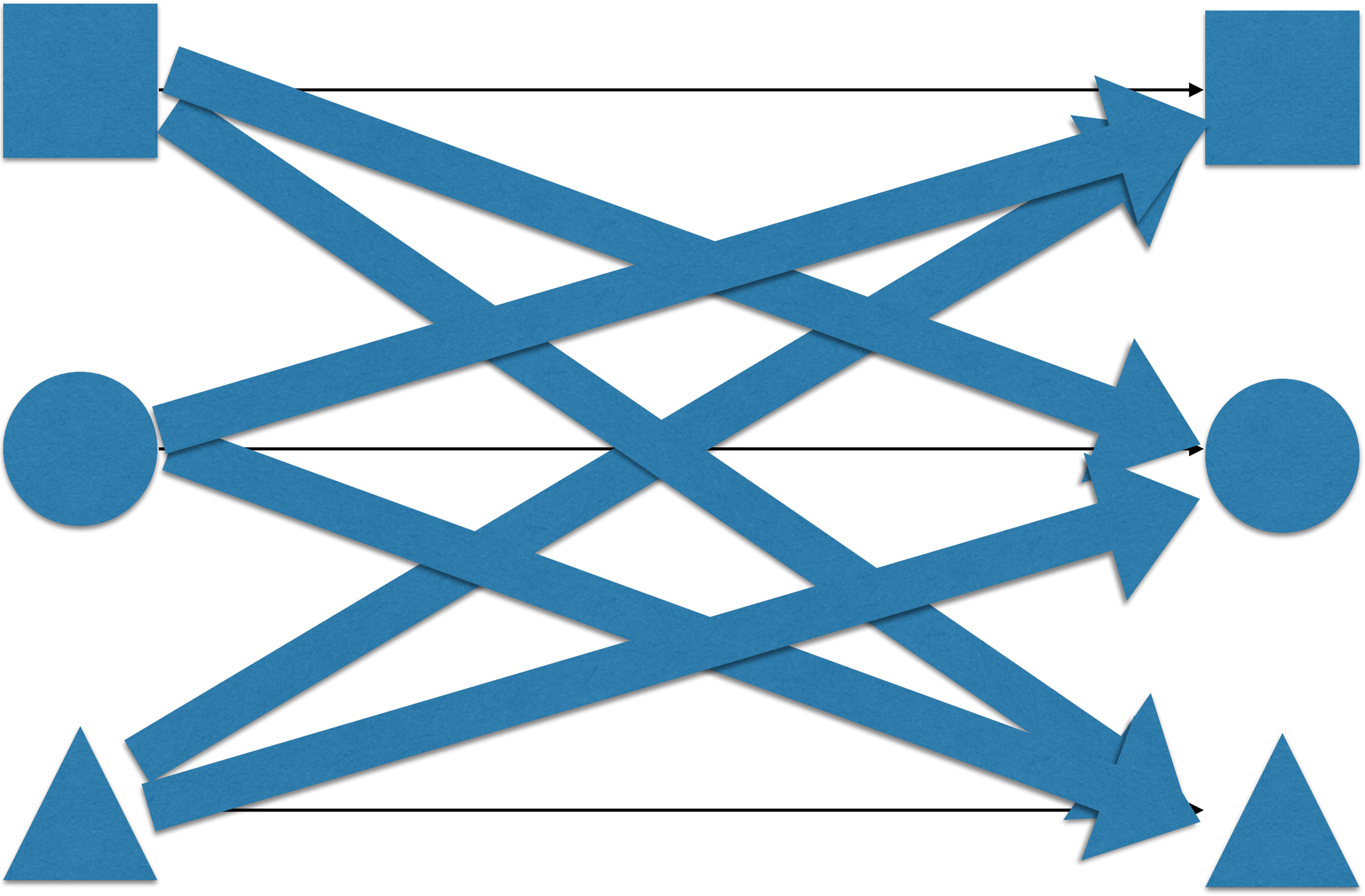
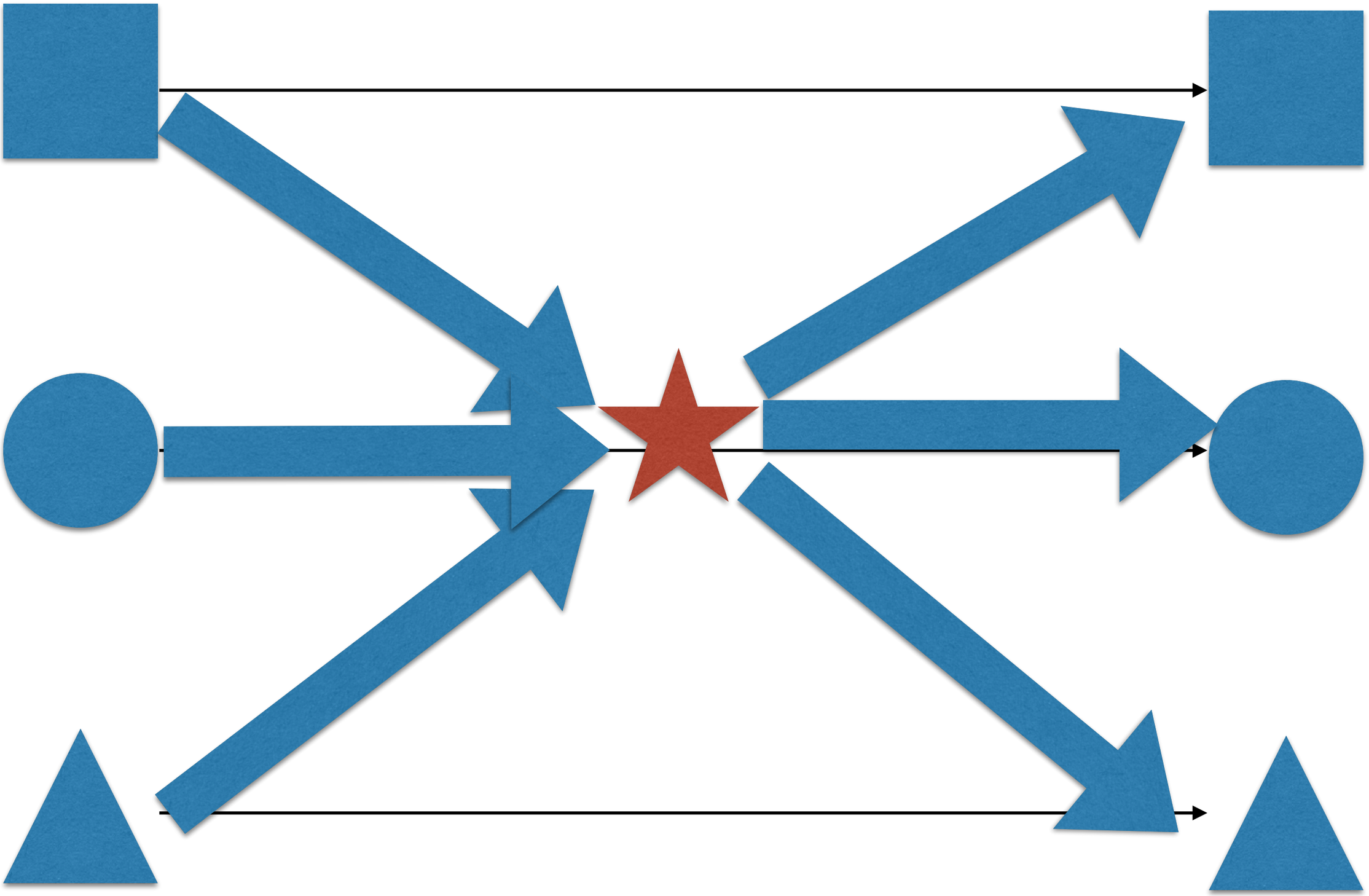
Schema Interoperability

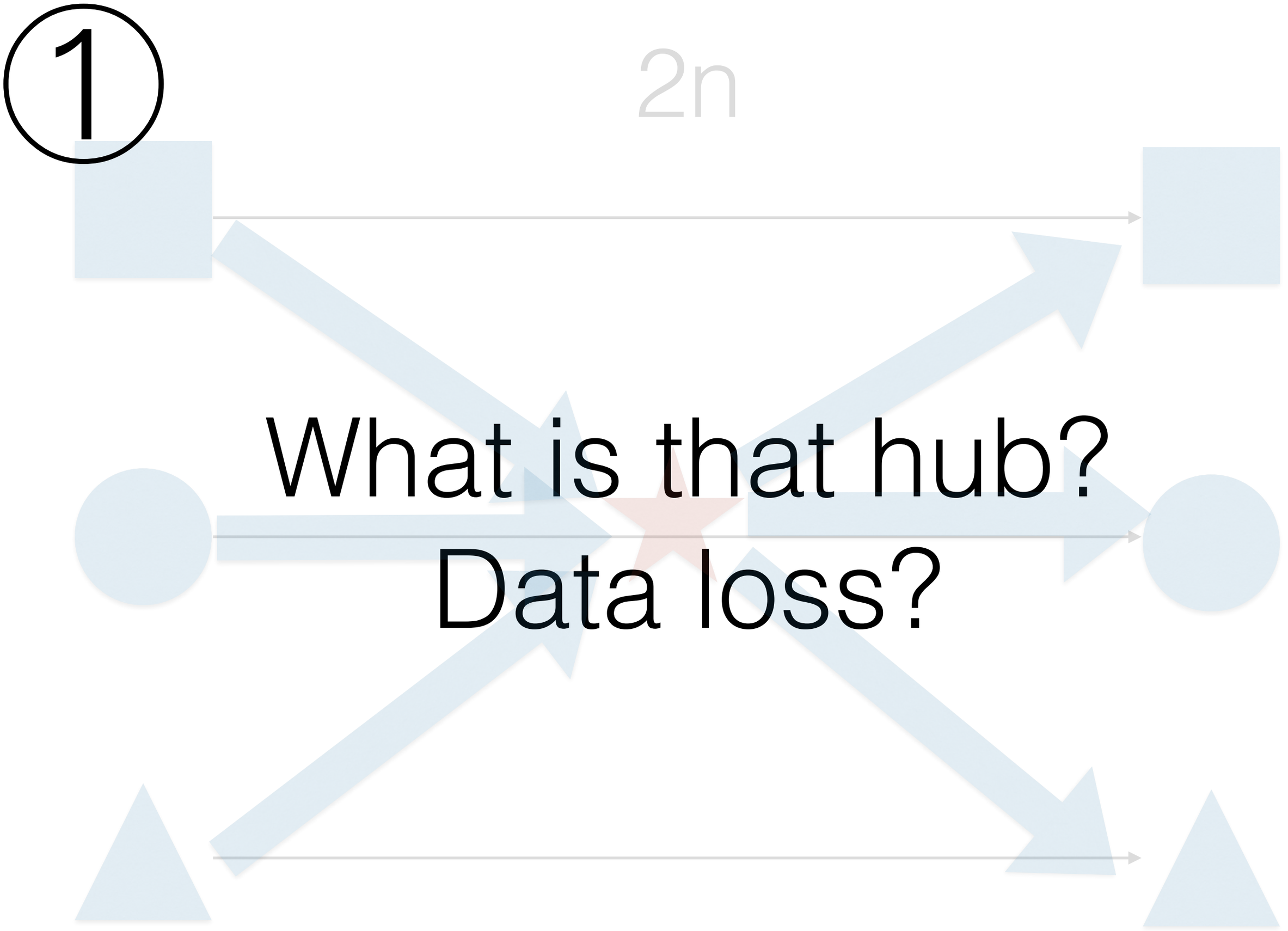
- Good discussions at the IAB IoTSI workshop and T2TRG meeting in March
  - »There will not be *one* schema,
    not even *one* schema language«
  - Collect, integrate schemas/ontologies
  - Translate between schema/modeling languages

$n^2 - n$



2n





What is that hub?

Data loss?

②

Translating **data** between data models

vs.

Translating data **models**

③

Data/Information Models

vs.

Interaction Models

4

Semantic Level

Vocabulary

Taxonomy

Meaning

Ontology

Information Model

Data Model

Abstract Syntax

Serialization

Concrete Syntax

Marshaling Scheme

Message Transport Format

Encoding

⑤

How far can we get?

Limits to translation (e.g., security?)

Schema Interoperability

- What is the research that we should be encouraging?

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Meeting Planning

- IoT SDO Outreach:
  Keep up the pulse

- Open Source:
  Start with RIOT, what next?

- Academic Research venues:
  Start planning for 2017

Meeting Planning

- Pretty firm:
  - Track at RIOT Summit, Berlin 2016-07-15/-16 (Fri-Sat) (before Berlin IETF96)
  - ~Thu-Sun September 22-25 (with and after W3C at Lisbon)
- To do:
  - around IETF97 at Seoul? (November 14-18 2016)
  - Good research venue(s) (2017)

IoTSU

- Software Update of IoT devices
  - Not a research problem!
  - Or is it?
  - June 13–14, Dublin? (Deadline May 22?)