T2TRG: Thing-to-Thing Research Group

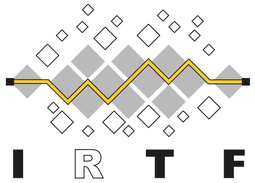
T2TRG Work Meeting on Digital Twins, May 4, 2022

Chairs: Carsten Bormann & Ari Keränen

Note Well

- You may be recorded
- Be nice
- The IPR guidelines of the IETF apply:
  see **http://irtf.org/ipr** for details.

Note Well – Intellectual Property



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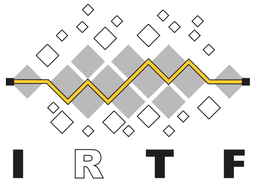

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- See RFC 7154 (Code of Conduct) and RFC 7776 (Anti-Harassment Procedures), which also apply to IRTF

Goals of the IRTF

- The Internet Research Task Force (IRTF) focuses on longer term research issues related to the Internet while the parallel organisation, the IETF, focuses on shorter term issues of engineering and standards making

- **The IRTF conducts research; it is not a standards development organisation**

- While the IRTF can publish informational or experimental documents in the RFC series, its primary goal is to promote development of research collaboration and teamwork in exploring research issues related to Internet protocols, applications, architecture, and technology
- See “An IRTF Primer for IETF Participants” – RFC 7418

Administrivia (I)

- (Blue sheets maintained by meetecho)
- Note-takers: **https://notes.ietf.org/notes-ietf-interim-2022-t2trg-02-t2trg**
- Jabber (= Meetecho chat)
  - **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/2022-05-digital-twins**

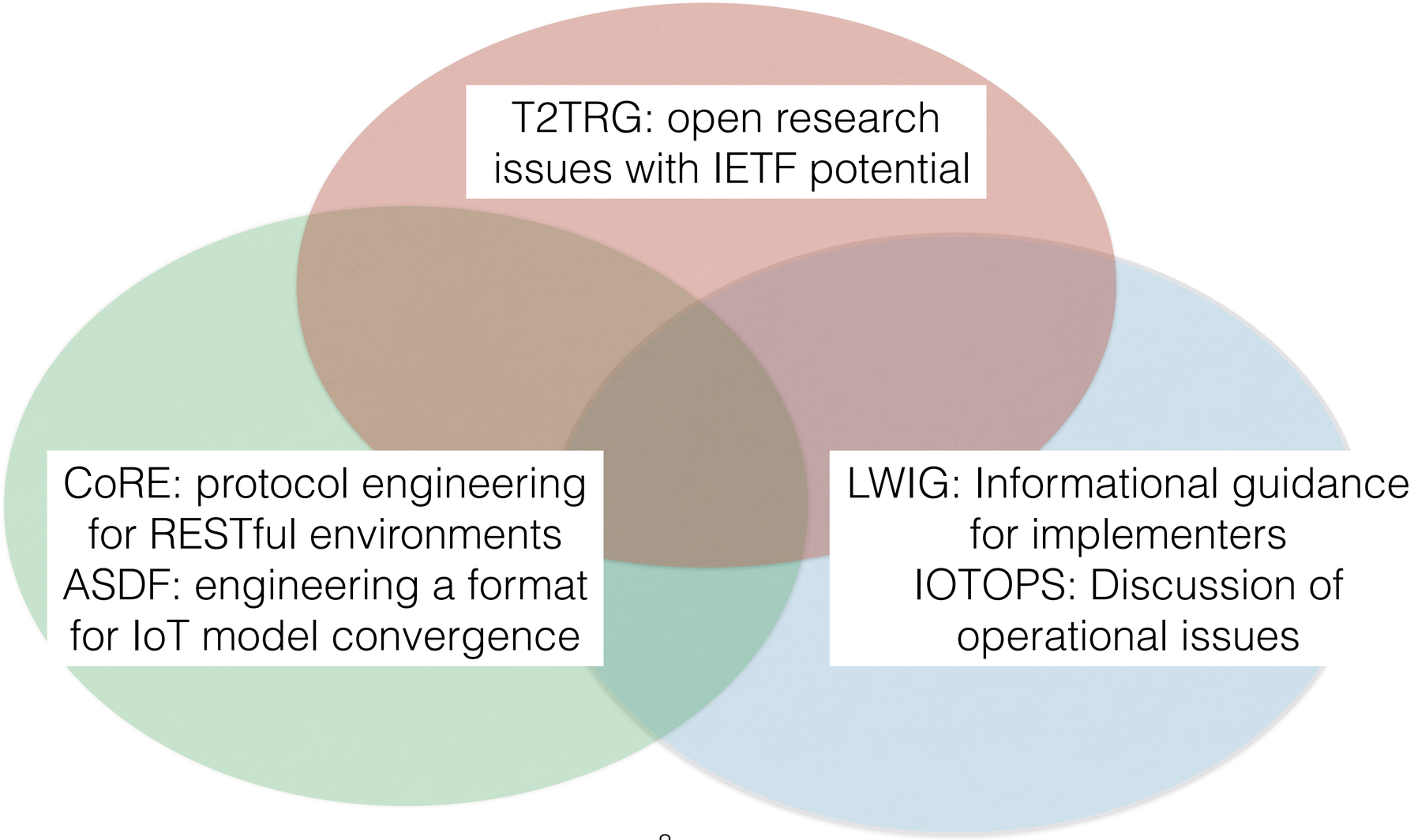
T2TRG scope & goals

- 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

IRTF and IETF

IRTF
(Research)

IETF
(Engineering)



IETF and IRTF in IoT

- IETF ➔ communication technology standards for IoT, defining or adapting:
  - Internet Protocol adaptation layers (and related protocols such as IPv6 ND)
  - transfer protocols, profiles for transport protocols
  - security mechanisms, application data formats, and data modeling

  ➔ 16 specific Working Groups since 2005, help from many other WGs

- IRTF: foster research that can inform such standardization
  - T2TRG focusing on IoT; also in other RGs such as COIN

Digital Twins

- Increasingly popular concept for IoT systems
- “Digital Twins” (DT) = digital representations
  - that are counterparts of entities and processes in the physical world
  - that are being synchronized with those physical entities.
- In IoT space, often involves sensing the state of physical objects and changing their state

T2TRG Work Meeting on Digital Twins

- try to capture relevant terms (including “DT” itself)
- explore the state of applicability of IETF technologies in building DTs
- ➔ towards identifying gaps, guiding:
  - further standards development at the IETF
  - research opportunities at the IRTF
- focus on identifying questions now, answers later

DT: Related concepts

- Architectural concepts addressing related problems:
  - Proxies (REST), Brokers (Message Queues)
  - Related naming (URIs, topics)
- Implementation support that may be used for setting up DTs
  - Edge Computing, In-Network Computing
- Modeling that may be sharable
  - Data/Interaction modeling
  - Security modeling (and generic security models)

Agenda

Time (UTC)	Who	Subject
13:00	Chairs	**Welcome and Intro**
13:10		**Digital Twin Consortium View**
13:10	Anto Budiardjo	big picture: digital twin architecture
13:25	Toby Considine	a technical view: CNS and CP
13:40		Clarifying questions
13:50		**IETF, IRTF view**
13:50	(Chairs)	NMRG activities: Network Digital Twin
14:00	Carsten Bormann	SDF and the ASDF WG
14:10	Petri Laari	Experiences with data model conversions & SDF for Digital Twins
14:25	Bin Xiao	Building Digital Twins on interoperable IoT technologies
14:40		**Discussion**

NMRG: Digital Twin of Network

- NMRG: Network Management Research Group
- "digital twin network" as a virtual representation of the physical network
  - **data** (historical, real-time),
  - **models** (emulate, diagnose)
  - **interfaces** (Network--DT, DT--apps)
- used to **analyze**, **diagnose**, **emulate**, and then **control** the physical network
- Requires real-time and interactive mapping:
  - between the physical network and its DT Network (**pairing**, vertical)
  - between multiple instances of DT Networks (**coupling**, horizontal)
- can switch off real-time interaction ➔ emulator, e.g. for trying new configs

Proposed NMRG reference architecture