draft-icnrg-icniot-architecture-00.txt IRTF/ICNRG, 96, Berlin

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Draft Outline

Goals of this draft

- Follows the challenges draft
  - draft-zhang-icnrg-icniot-requierments-01.txt
- The draft considers a typical IoT system setup and middleware functions.
- We provide ICN centric discussions on these middleware functions.
- The discussions are presented as potential approaches (but doesn’t restrict itself) to realize these middleware functions.

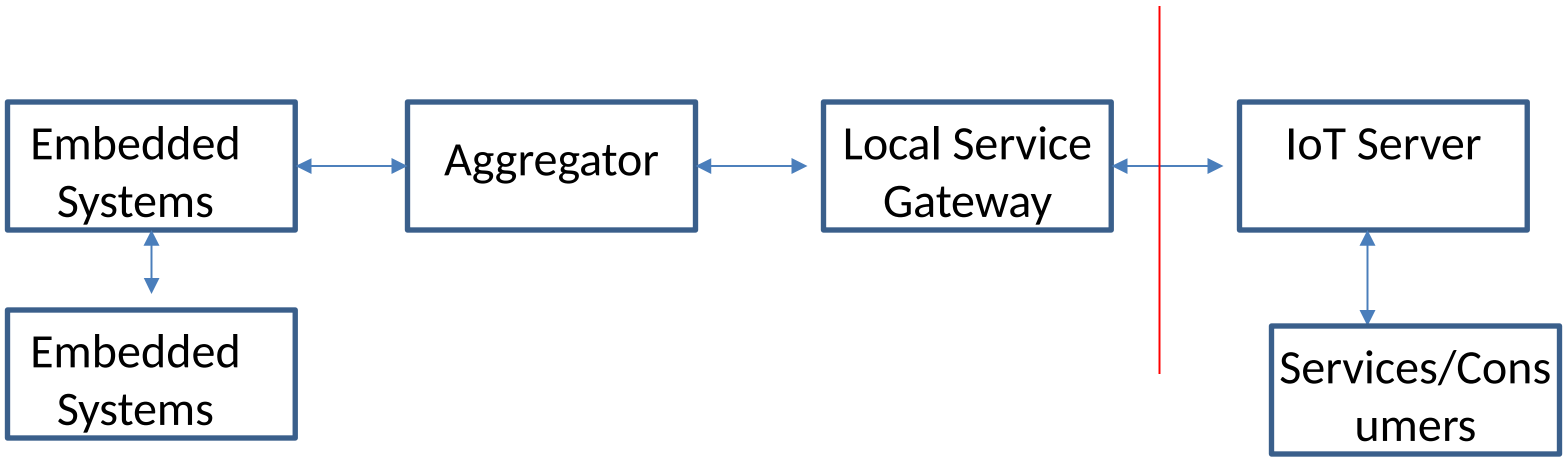
ICN-IoT: ICN's suitability for IoT

- **Serve as a unifying platform for all IoT services**
  - Highly fragmented today.
- Why ICN-IoT ? (discussed in more detail in draft-zhang-icnrg-icniot-requierments-01.txt)
  - **Naming**
    - Fundamental to IoT systems.
  - **Scalability**
    - Through content locality, local computing and multicasting.
  - **Resource Efficiency:**
    - Suitable for constrained and non-constrained networks segments. Information-centricity helps in transmitting only useful information.

ICN’s suitability for IoT

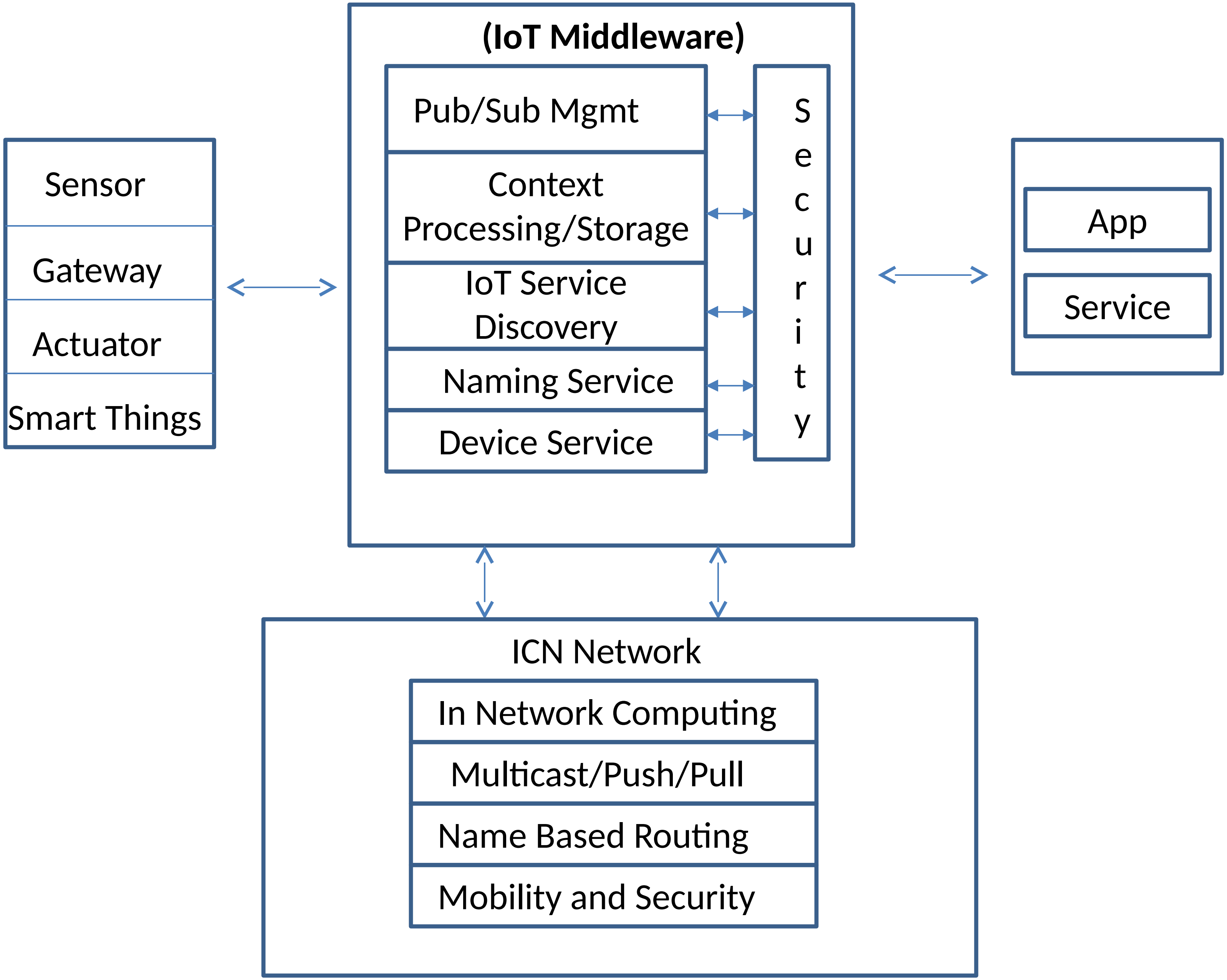
- **Localize Traffic Pattern**
  - ICN allows local data production, processing, consumption
- **Context-aware communication**
  - Allows processing of application, device level contexts in the network layer.
- **Seamless Mobility Handling**
- **Self Organization**
  - Using simplified stacks and initial data for bootstrapping.
- **Distributed Data Storage and Processing**
- **Security and Privacy**
- **Communication Reliability**
- **Support for Ad Hoc Mode**

ICN-IoT System Architecture



- **Embedded Systems**: Sensors, Actuators, with relay enabled to reach the aggregator.
- **Aggregator** : Inter-connects heterogeneous ES within a local IoT network. Executes, device discovery, service discovery, and name assignment. Aggregators themselves can be fully functional devices.
- **Local Service Gateway** : Administrative boundary between local IoT system and the global IoT system. Naming Service, Access policies for IoT devices/data, Context processing of IoT data.
- **IoT Server** : Maintains subscription membership, data look up service. Unlike current IoT servers, ICN-IoT servers needn't be in the data path, may only play the role for authentication and access control.

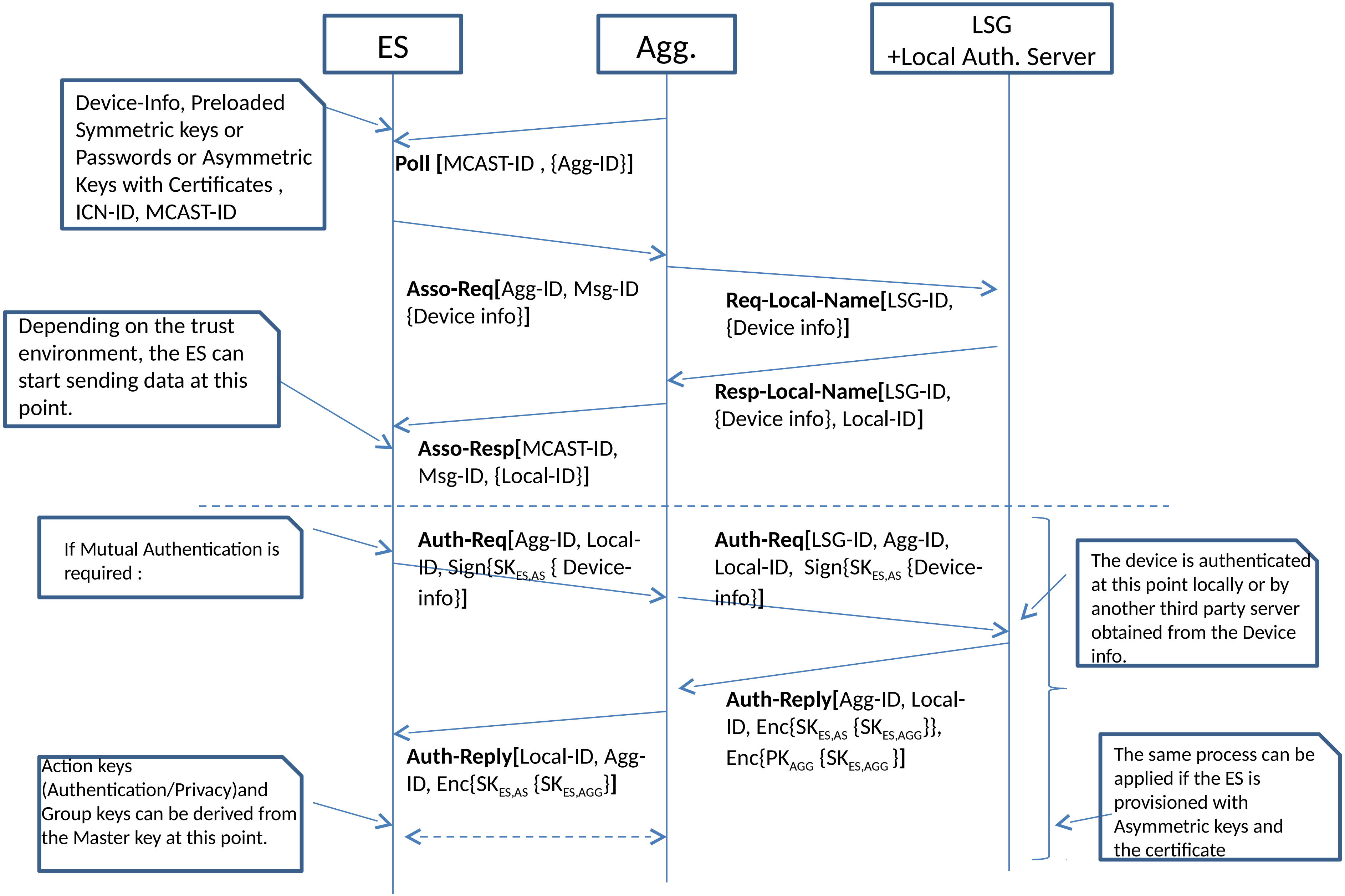
ICN-IoT Middleware Functions



Device Discovery

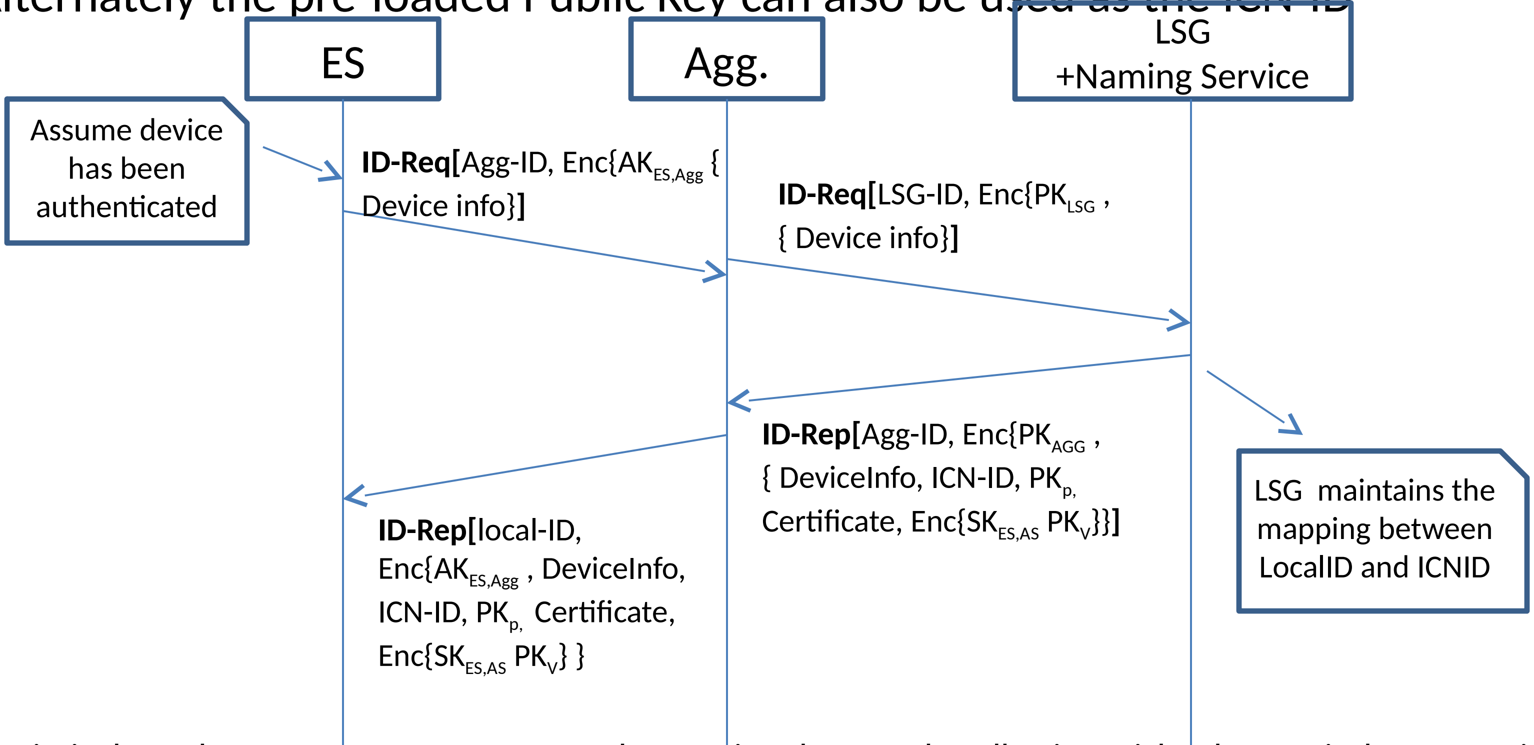
- Expose new devices to the rest of the system, aggregator, LSG, IoT server.
- ICN allows contextualized discovery
  - Using Service defined Multicast-IDs via names
- The authentication service can be co-hosted by the LSG or the IoT server.
- Assumption is the ES is shipped or locally provisioned with Keys for authentication and MCAST-ID for discovery.
- During the device discovery a local-ID is assigned fro routing, which can be derived from the global ICN-ID.

Device Discovery



Naming Service

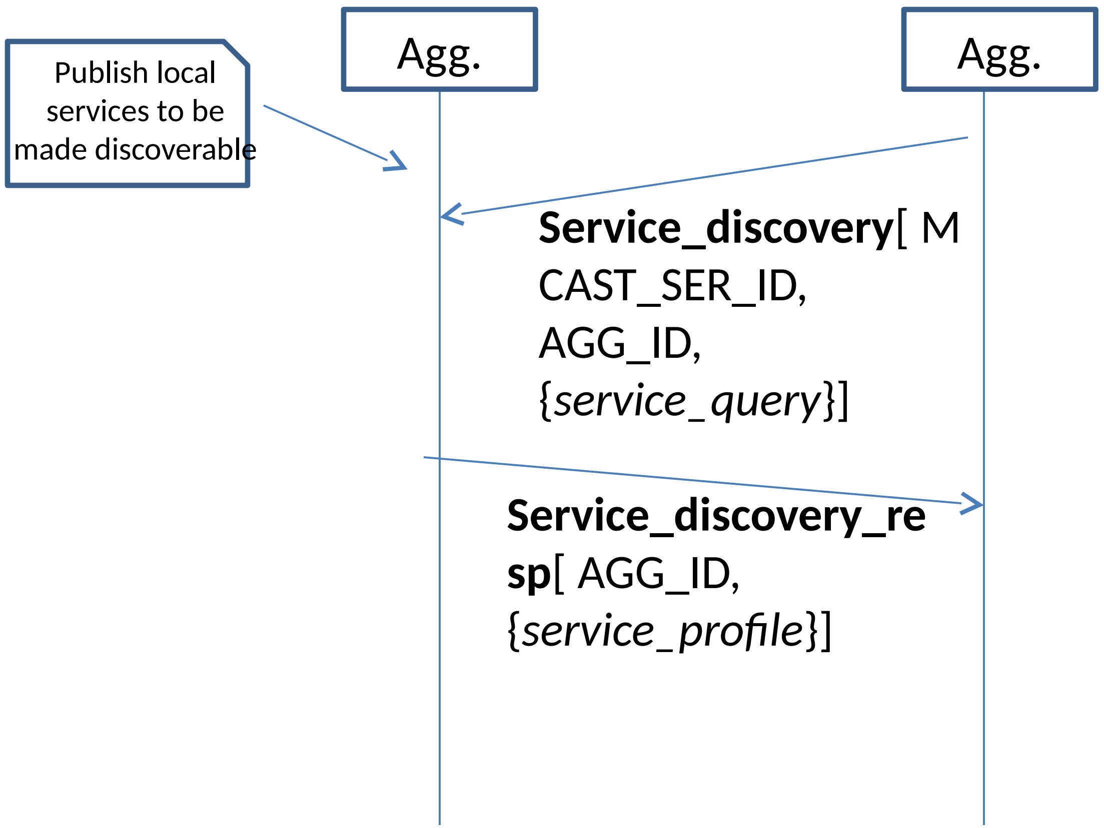
- The goal here is to assign persistent ID to the ES.
- If data is re-processed at the LSG, there is no need for global IDs.
- Local-ID to global ICN-ID mapping is managed at the LSG to allow global reacheability
- If resource permits IoT networks can use ICN-ID in the IoT network too.
- The ICN-ID can be self-certified or URI.
- Alternately the pre-loaded Public Key can also be used as the ICN-ID



[1] Sugang Li, Jiachen Chen, Haoyang Yu, Yanyong Zhang, Dipankar Raychaudhuri, Ravishankar Ravindran, Hongju Gao, Lijun Dong, Guoqiang Wang and Hang Liu, "MF-IoT: A MobilityFirst-Based Internet of Things Architecture with Global Reachability and Communication Diversity", IEEE/IoTDI 2016

Service Discovery

- Generally with ES conveys its capabilities to the aggregators which then exposes it as a service.
- Service discovery is among the Aggregators, and can be service-centric.
- Service-specific multicast IDs can be defined to logically separate service groups.



Context Processing and Storage

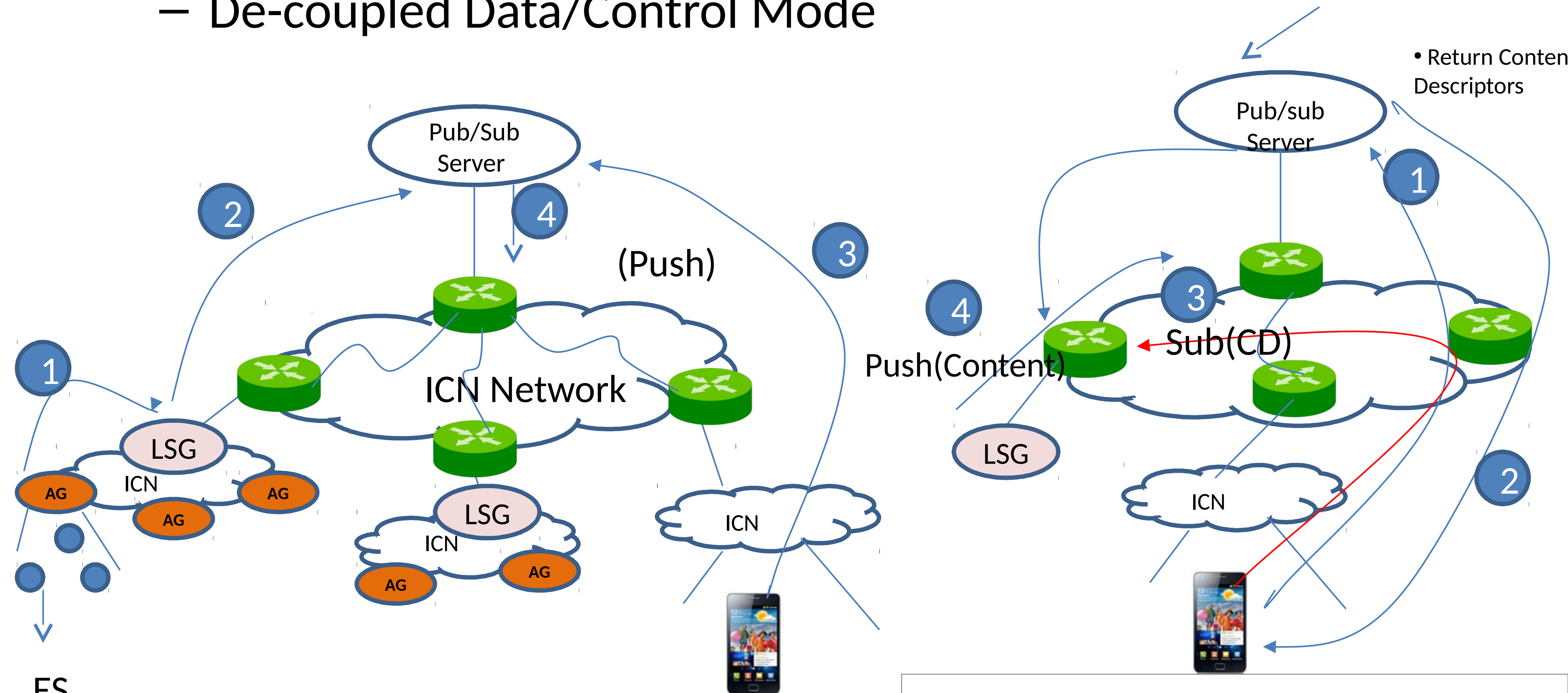
- The goal is satisfy upper level application context to lower level device and network layer contexts.
- Application context include event filters, time parameters, statistical expressions (max/min/avg..) etc.
- Device level context include type, location, battery level etc.
- Network level includes ICN names, topology, routing, forwarding, context attributes
- In-network computing in the edges can optimize information flow matching application requirements to network and device level requirements.

[1] Lijun Dong, Ravi Ravindran, G.Q.Wang, "ICN based distributed IoT resource discovery and routing", IEEE/ICT, 2016

PUB/SUB System

- **Two models have been discussed.**
  – Rendezvous Mode of Pub/Sub
  – De-coupled Data/Control Mode

Only handles Authentication and Access control and providing intial contend discriptors



- The control and data push is handled by the pub/sub service.
- ICN multicasting handles content distribution scalability

- The pub/sub service is integrated in the network layer, e.g. COPSS uses Randezvous Nodes in NDN.
- In MobilityFirst service GUIDs can be defined for multicasting

User Registration and Content Distribution

- Security considerations when subscribers registers with the pub/sub service.
  - Secure transfer of Service-IDs/Content Descriptors
- Content distribution security considerations.
  - Discussion using Symmetric Keys, PKI, Group Keys, hybrid IBC/PKI [2] is provided

[1] Jiachen, C., Mayutan, A., Lei, J., Xiaoming, Fu., and KK. Ramakrishnan, "COPSS: An efficient content oriented publish/subscribe system", ACM/IEEE ANCS, 2011.
[2] Zhang, X., "Towards name-based trust and security for content-centric network", Network Protocols (ICNP), 2011, 19th IEEE International Conference on. IEEE, 2011.

Heterogeneous Networks

- IoT named content, services, resources could be hosted in heterogeneous networks, IP/ICN/Adhoc/DTN etc.
- Discussions follow the considerations from Inter-Names paper [1][2].
  - Inter-operability between heterogeneous named networks
  - Name Realms and Network Realms
- Three important architectural components
  - A global NRS operating gluing heterogenous networks and name realms
  - Name Protocol bridges to inter-connect multiple transports
  - Inter-domain management to enable cooperation between IoT services in multiple domains at resolution, control, and data plane level

[1] Blefari-Melazzi, A., Mayutan, A., Detti, A., and KK.Ramakrishnan, "Internames: a name-toname principle for the future Internet", Proc. of International Workshop on Quality, Reliability, and Security in Information-Centric Networking (Q-ICN), 2014.
[2] Piro, G., Signorello, S., Palatella, M., Grieco, L., Boggia, G., and T. Engel, "Understanding the Social impact of ICN: between myth and reality", AI Society: Journal of Knowledge, Culture and Communication, Springer, pp. 1-9,2016.

Future Work

- Based on feedback…