Monitoring and Management for Home Data Network

LIG - SIGMA
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Context

Goal

Query the digital home to:
Enhance diagnostics
Monitor its usage
Assist the device management
The solution must be **flexible** and must fit at best to the user's needs

Issues

Lots of heterogeneous data streams
Streams must be considered as a whole (past, present, future?)

Approach

Merge data stream management concepts with traditional DB/DW

The Digital Home

Foremost, a network of smart devices
Massive producer of data streams

- Service uuid:123573 = I'm starting
- Device Gateway = CPU Rate: 62%
- Interface 00:b3:... = IP 192.168.0.2
  PacketSent 847452
- Service TV = Quality of Experience 4/5
- Link TV-Gateway = Bandwidth =
  Used: 12Mbps
  Available: ~65Mbps
- Service uuid:123723 = I'm stopping
- Device PC = OS Ubuntu SMP
  Installed softwares = {...}
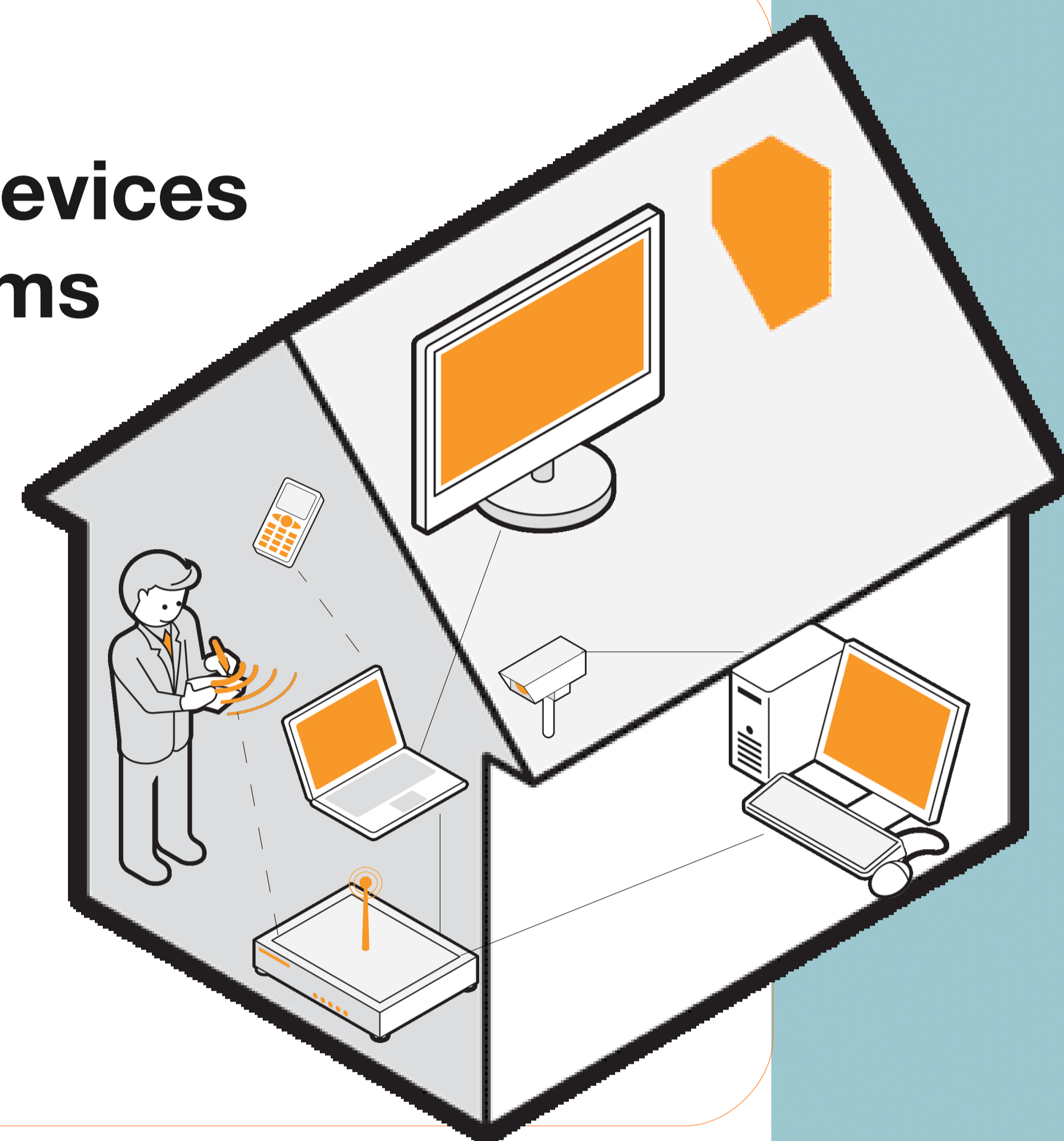
Query Optimization

Each continuous query can be decomposed as an algebraic operator tree.
Astral: Mathematical definition of those operators
- Clarifies semantics
- Formalizes systems to enable mediation
- Eases coupling with any relational system (DBMS/DWH)
- Is a first step to optimize query plans

Query sharing

- Equivalence properties on subtrees yet to be defined.
- Synchronization between two queries started at different timestamps.
- Impact of local reconfigurations.

Algebraic Optimization

- Rewriting systems based on algebraic properties: commutativity, associativity, distributivity of operators
- Consequences on query sharing

Physical Optimization

- Algorithms and data structures adapted to streams characteristics.
- Rules, yet to be identified.
- Example: How to use index when performing a join on a database

Processing dissemination

- Some devices are able to perform subclasses of queries
- Trade-off between on-device cost and global optimization to be made
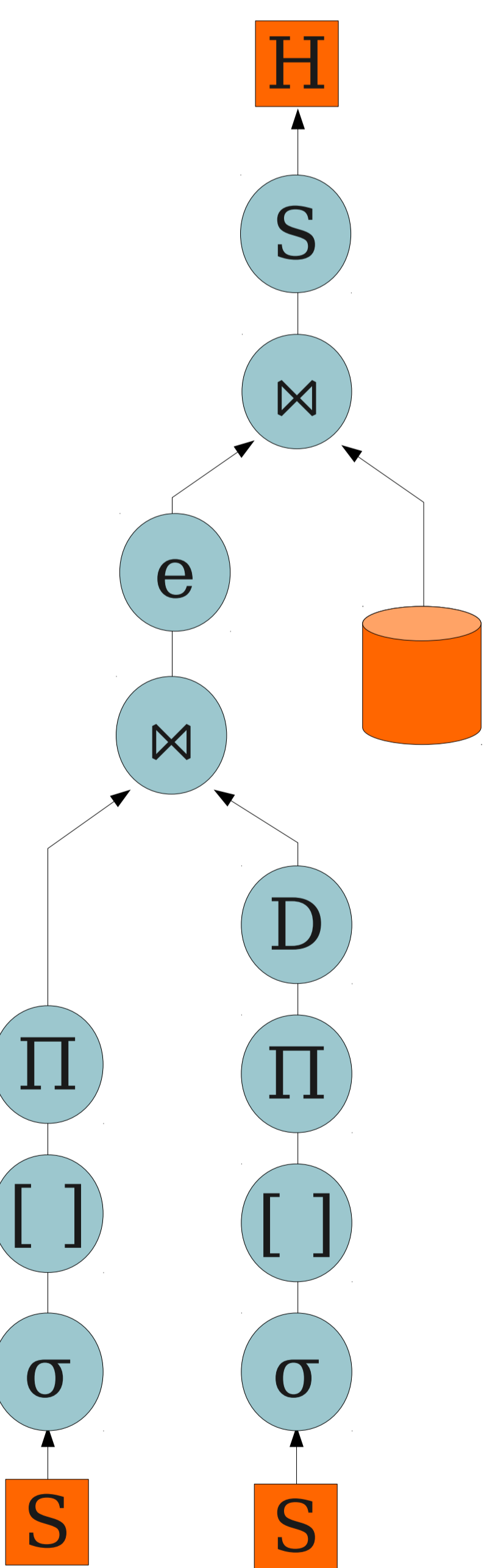
Coupling streams/databases

For some diagnostic applications, a detailed historic is necessary. Its granularity and its usage depends heavily on application needs.

Modeling the Digital Home

- Create a model that reflects every notions of the digital home.
- Merge knowledge from many domains: hardware, system, networking, software engineering, expert domains

Coupling streams/historians

- Coherence between the structure of streams and the database relations.
- Integration of the normal form notion as well as the concept of keys on a stream.
- Example: What is the stream of bandwidth usage between applications 'Media Server' and 'Media Renderer'? (see figure)
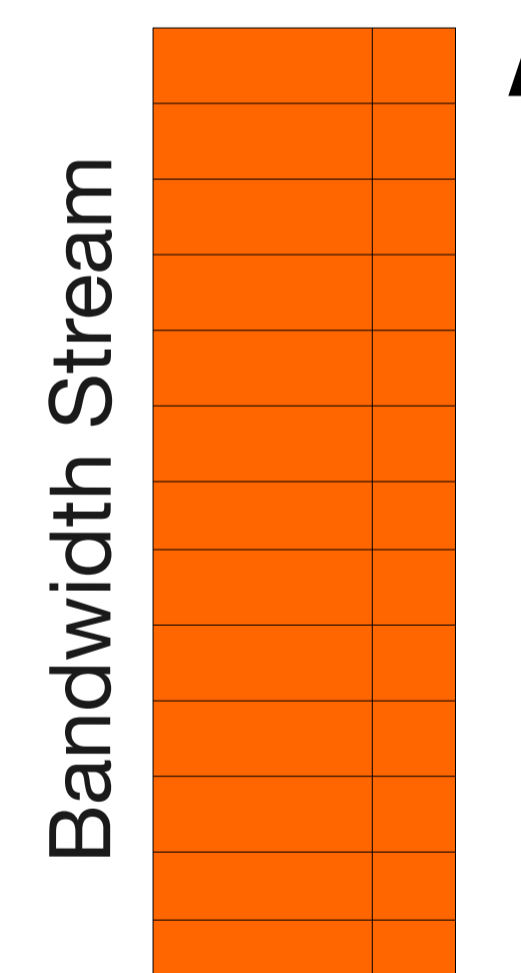
Historian as a data source

- A data historian can be perceived as a temporal relation for a data stream management system.
- Impacts on ACID properties?
- Applications: Simple identification, behaviour analysis, fraud detection, long complex event processing
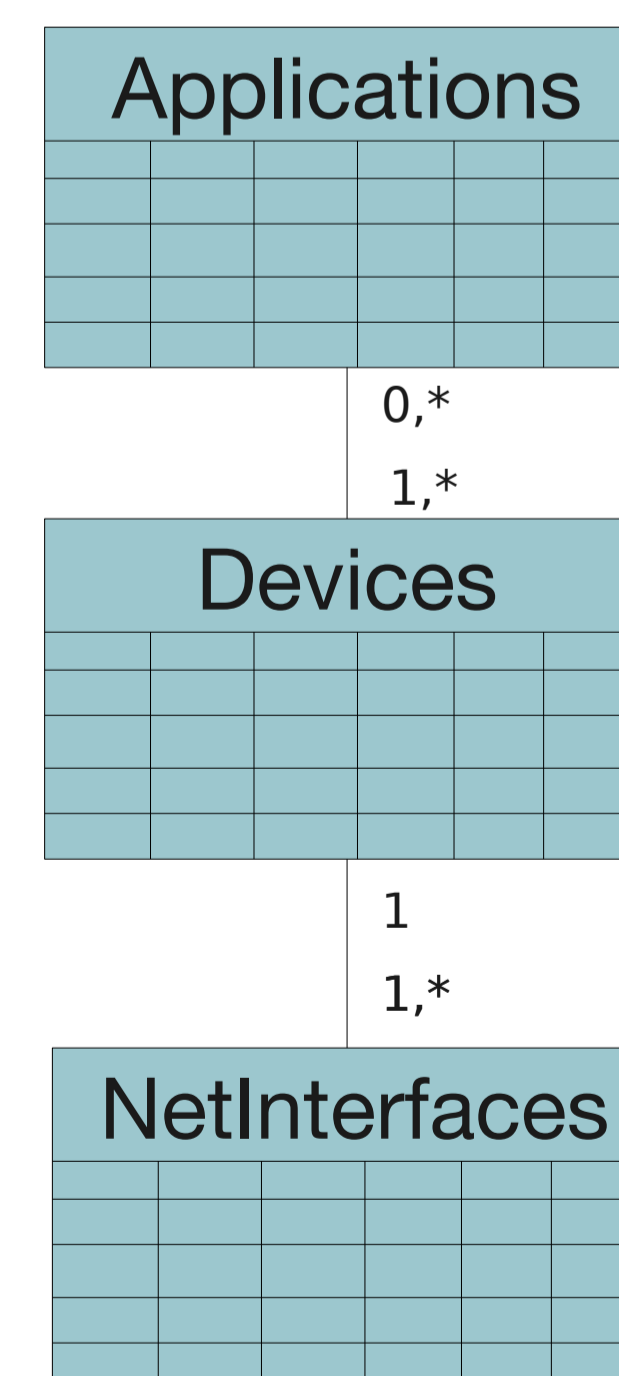
Historian management

- Definition of aggregation/deletion rules to manage obsolete data.
- Usage of user preferences to fit to the user's needs.

Bandwidth Stream

Applications
0,*
1,*
Devices
1
1,*
NetInterfaces

- *Astral* : Advanced Stream Algebra. http://sigma.imag.fr/astral
- *Loïc Petit, Claudia Lucia Roncancio and Cyril Labbé*, An Algebraic Window Model for Data Stream Management, MobiDE'10: Proceedings of the 9th International ACM Workshop on Data Engineering for Wireless and Mobile Access, *Indianapolis, IN, USA, June 2010.*
- *Levent Gürgen, Claudia Roncancio, Cyril Labbé and Shinichi Honiden.* Data management solutions in sensing systems. Wireless Sensor Network Technologies for Information Explosion Era, *Studies in Computational Intelligence, Springer'10*