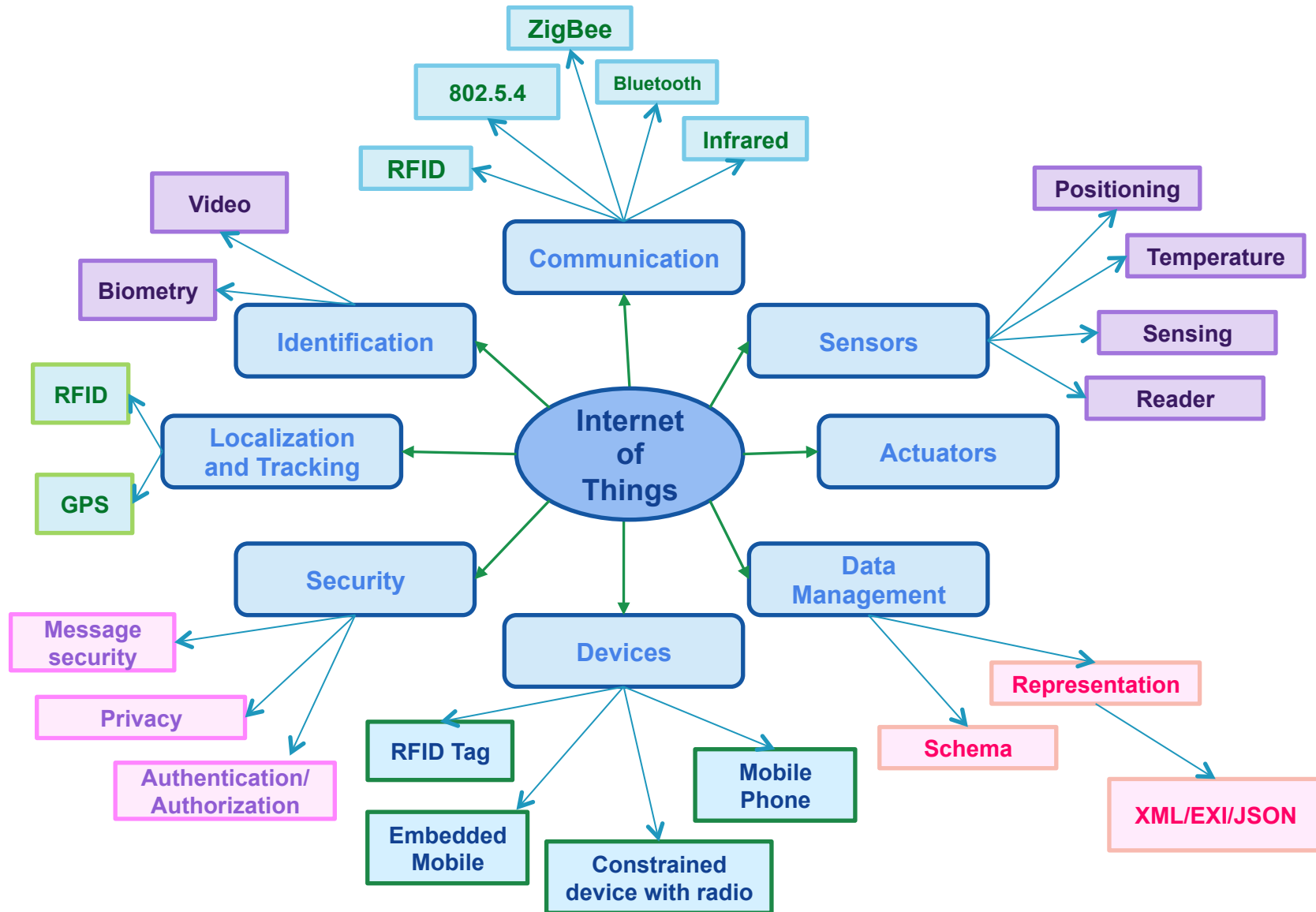


Connecting IPv6 capable Bluetooth Low Energy sensors with the Internet of Things

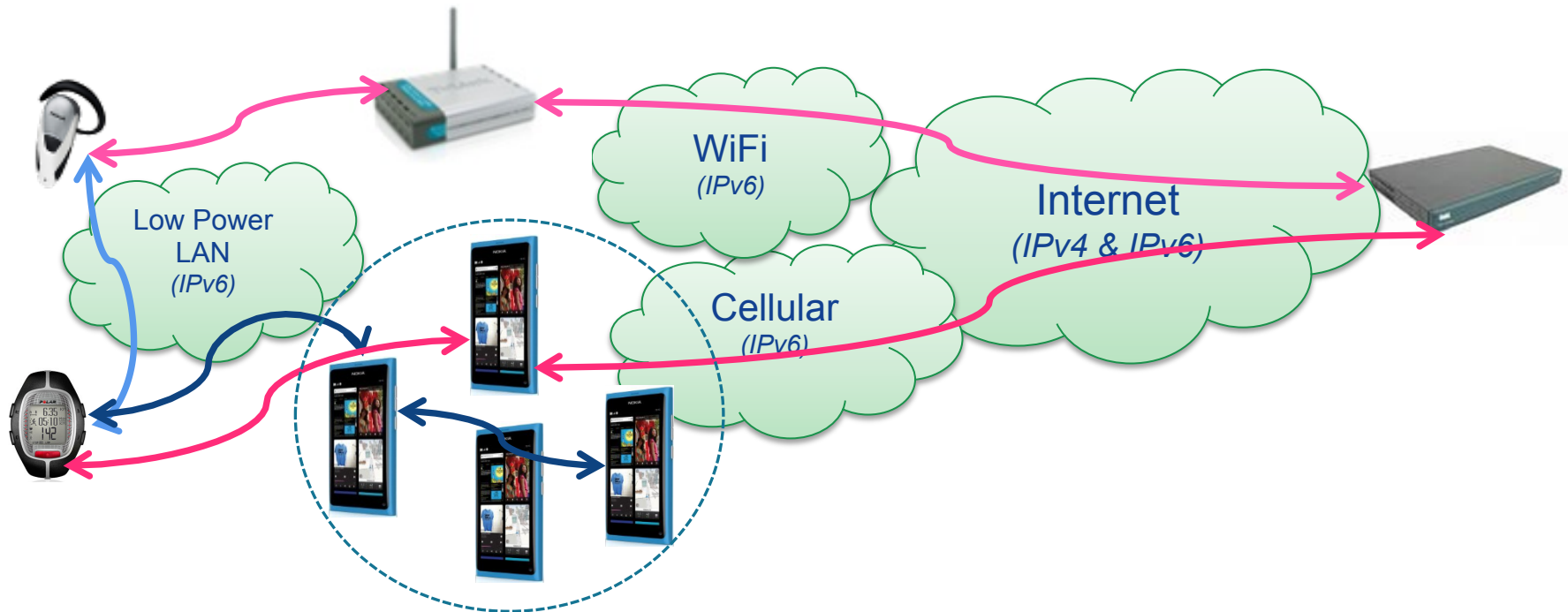
Johanna Nieminen (Nokia),
Future Internet SHOK
preconference 30.05.2012

IoT Taxonomy



Research challenges

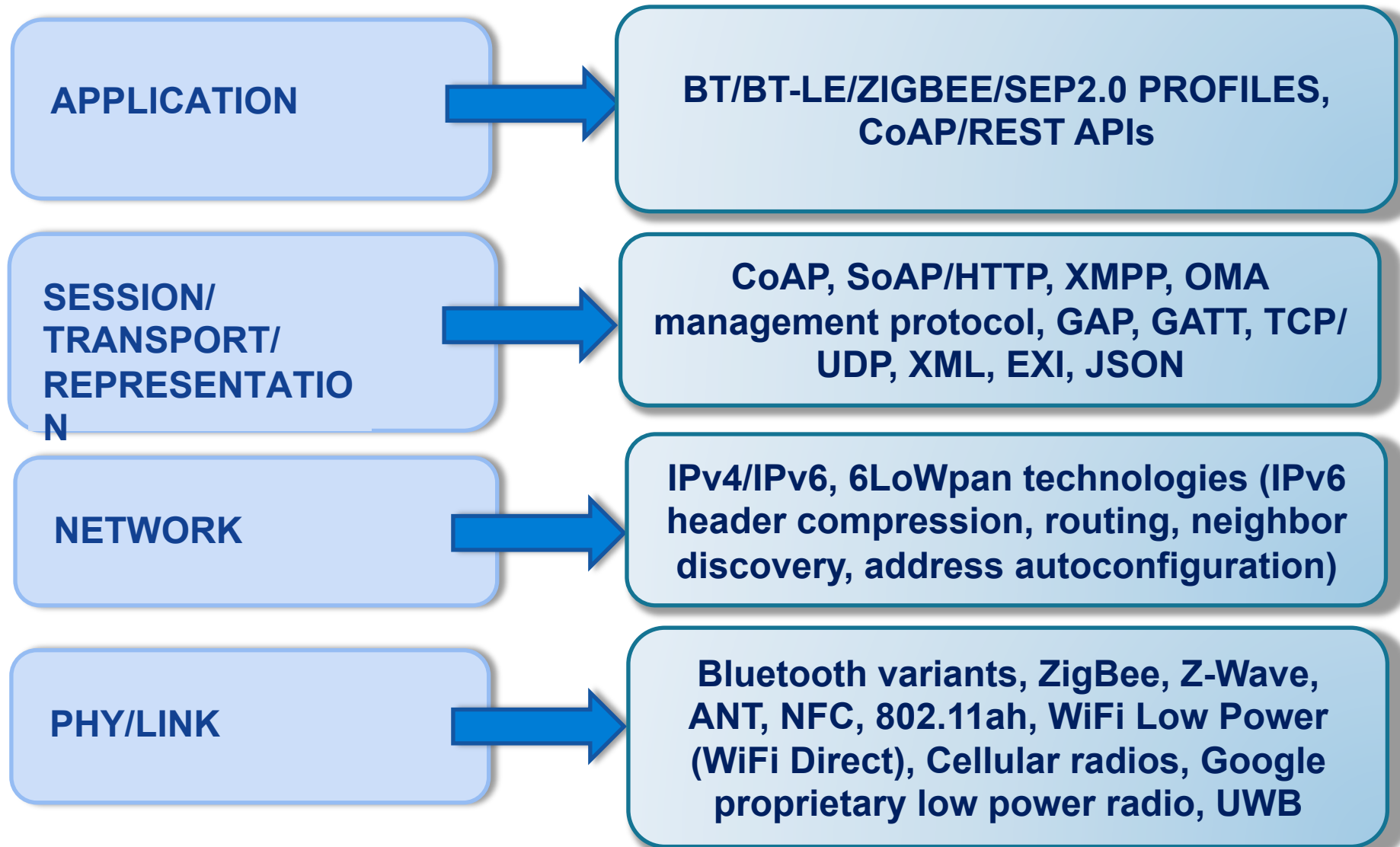
- **Billions** of sensors and actuators will be deployed in the next few years
- An emerging trend is to connect sensors with the Internet of Things (IoT)
 - Digitalization of the physical world
 - Technology disruption



Technology: IoT- Three views

- **The IETF/Internet view**
 - We should enable “constrained” nodes to connect to the Internet, and have low-overhead application, transport, security and auto-config protocols for them.
 - Otherwise it is the good old Internet, and apps are what app developers do. IP over everything and everything over IP. Emphasis on web concepts such as URIs, RESTful operations.
- **The M2M/cellular view**
 - Cellular networks should serve efficiently the increased M2M deployment, using IP or non-IP (SMS) methods. Focus on access-operator centric deployments. Internet use cases supported as a side effect, though.
 - A generic “service layer” for constrained nodes is needed covering addressing, security, device management etc. IP is the baseline, but focus on higher layers.
- **The low-power radio view**
 - Each low-power radio should include its own protocol stack and application profiles to communicate within a “subnet”. IP is extra overhead. Internet/cloud use cases are important, But data can be conveyed to Internet by applying gateways.
 - This is a valid approach e.g. for BT-LE with a smartphone as a gateway.

Networking and connectivity technologies



Bluetooth Low Energy use-cases

- Bluetooth Low Energy (BT-LE) is expected to appear in billions of devices and sensors in the next few years
- BT-LE can be implemented in several types of devices
 - accessories such as wrist units, key fobs, monitoring sensors, wearable sensors and programmable actuators
 - home gateways and mobile devices
- Today, BT-LE enabled sensors typically communicate locally with a central node
 - applications such as wireless audio and use of a mobile device in a hands-free mode
- Connecting BT-LE sensors to the Internet will
 - enable new types of use-cases and applications
 - enhance the operation of existing use-cases

Technical solutions

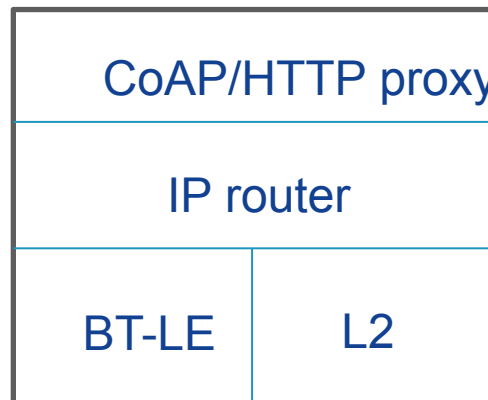
- **6LoWPAN standard** describes how to run IPv6 over IEEE 802.15.4 family radios in a power efficient way
 - at the moment there is no specification on how to run IP/IPv6 over other constrained links such as BT-LE
- It is currently possible to connect BT-LE sensors with the Internet using **protocol translation** in the mobile device acting as a gateway
 - However, solutions are application and operating system specific – do not scale and do not enable open web services creation environment for sensor application developers
- The most flexible approach would be to use **IP** for end-to-end communication between the sensors and a server
 - IPv6** would be the ideal protocol due to the large address space it provides.

Our solution

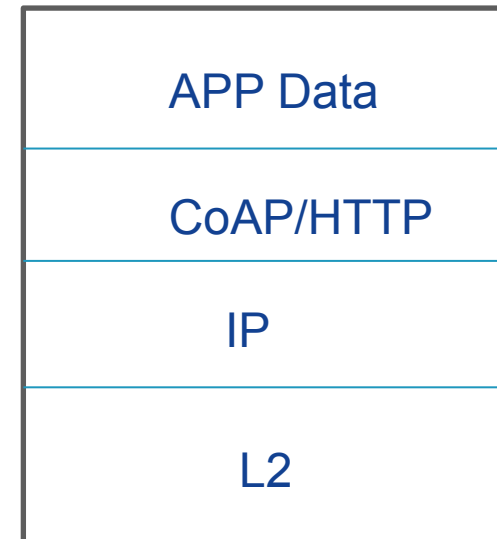
- We have designed **a generic BT-LE <-> Cellular IP router** and a CoAP/HTTP proxy on top of it



“BT-LE node”



“Gateway”

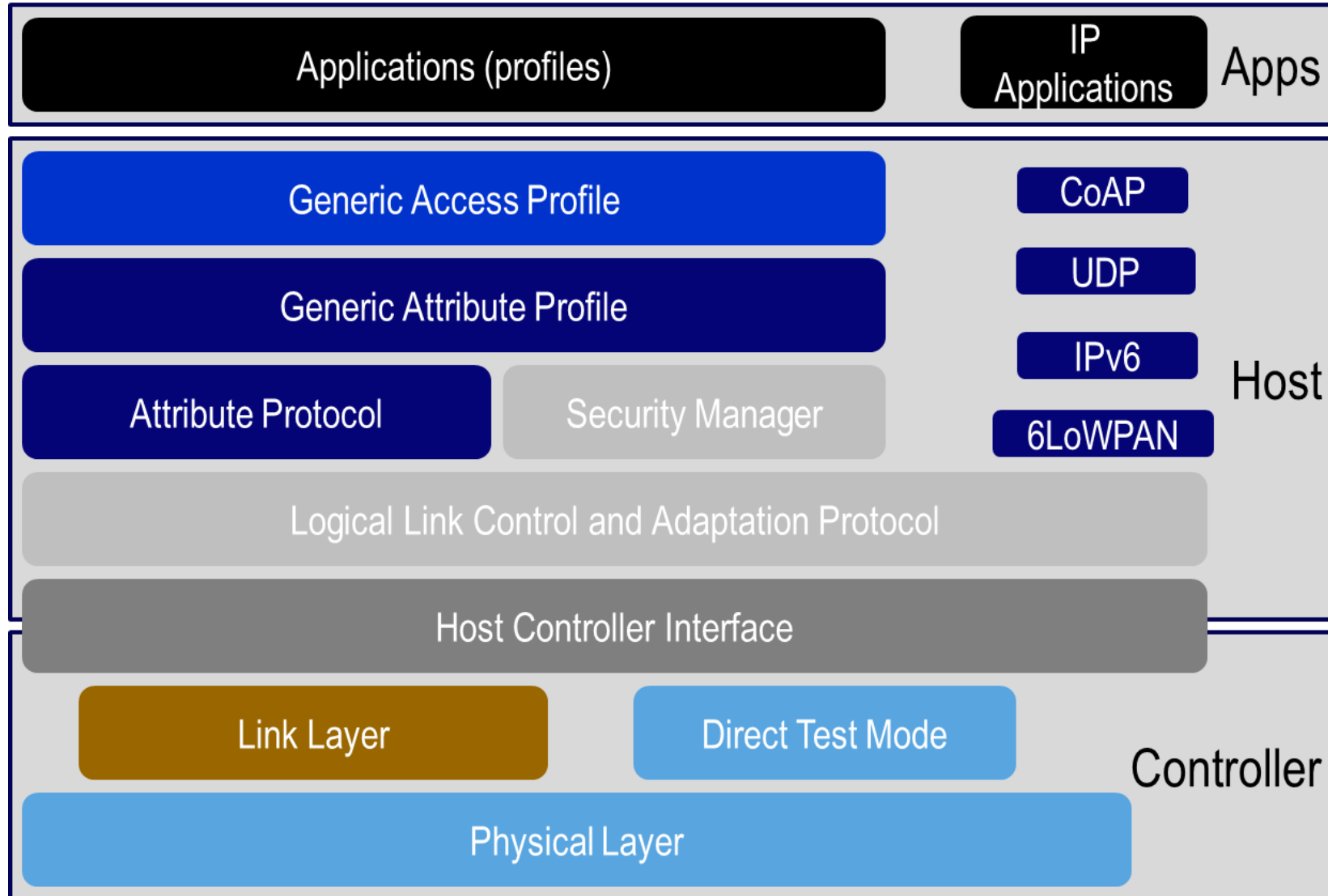


“Internet server”

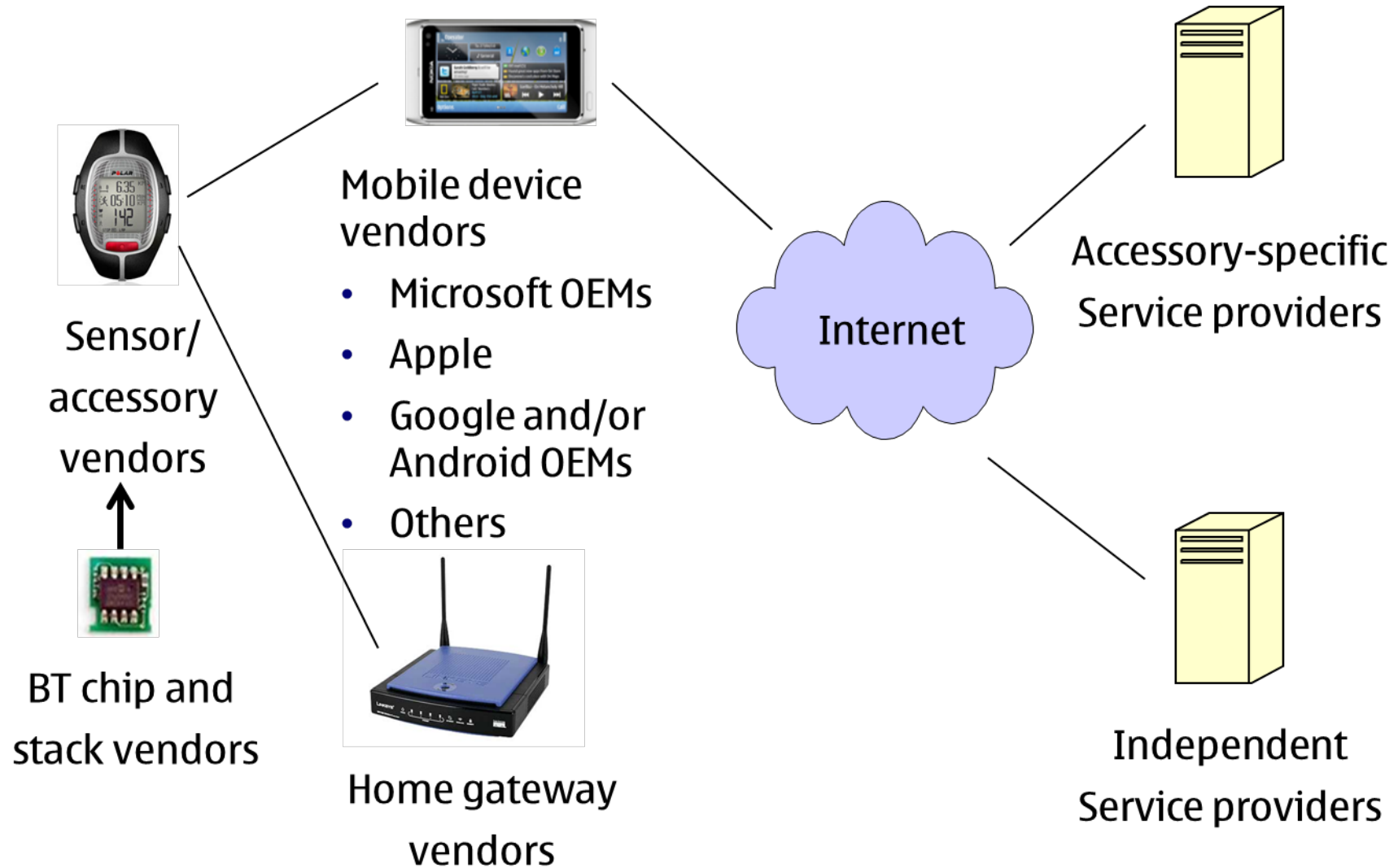
Our solution

- Key components of the solution include adapting 6LoWPAN for BT-LE
 - differences in the header compression and fragmentation functionality
 - BT-LE operates in a star topology, thus source and/or destination IPv6 addresses can be elided in many cases based on known context
 - Fragmentation will be performed in the link layer, not in the network layer
- Additional technical issues include
 - configuration, application protocol efficiency and security, context awareness as well as gateway operation

Proposed solution on Sensor



Resulting IP over BT-LE Ecosystem



Standardization

- IPv6 over BT-LE IETF draft Working Group Last Call completed, moving the draft to IESG approval queue
 - RFC expected in a few months
 - Other related drafts prepared
 - Starting to promote the concept through IPSO
- Sensor Internet protocol FRD approved in BT-SIG BARB
 - Goal is to have BT-SIG stamp on the solution, and a fixed channel ID reserved for IP traffic
- Nokia prototype implementation completed, interoperability implementations with another company already started

Prototype implementation: Internet connected heart-rate belt

