Andreas Scholz (andreas.as.scholz@siemens.com)

Beyond REST

Creating Automation Systems out of Things with REST

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- Motivation / Approach
  - Take the view of an automation system designer / engineer
  - Take the building blocks that are available (e.g. CoAP) and try to build a REST based solution
  - Identify what “feels strange” and what is “missing”

- The presentation uses home automation examples
  - The hope is that this provides an easy to grasp common ground for discussions
  - The examples have been selected to **illustrate** typical interaction scenarios from industrial / energy automation systems – they might not necessarily be the optimal solution for home automation

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Take with a big grain of salt!

Properties of / assumptions about automation systems

- **Distribution**: It is worthwhile to separate between
  - "Local" automation tasks (industry automation, wind parks, home automation, etc) that operate on a LAN-like system
  - "Global" automation tasks (smart grid, logistics, etc) that operate on an Internet-like system

Focus of this presentation

- **Ownership**: It is worthwhile to separate between
  - Systems with a strong "owner" (factories, plants, power plants) that has a lot of control over the behavior of its components
  - "Unreliable" systems w.r.t. availability and usage (pv panels in the smart grid)

Focus of this presentation

- **Rate of Change**: It is worthwhile to separate between
  - Control, which evolves slowly. Changes occur, but often the system will run "as-is" for months or years. Changes occur in a controlled manner in re-engineering phases.
  - Data acquisition (optimization, predictive maintenance, etc) which is more dynamic

Focus of this presentation

- **Data Flow**: The vast majority of data flow stems from planned (often periodic) interactions. Hundreds of control loops can run "in parallel", coordinated by a hierarchy of higher level systems. Ad-hoc interactions are rare.
- **QoS**: The primary concern regarding QoS is achieving deterministic behavior (latency, jitter, etc) for well-known workloads. Scalability / elasticity is second.

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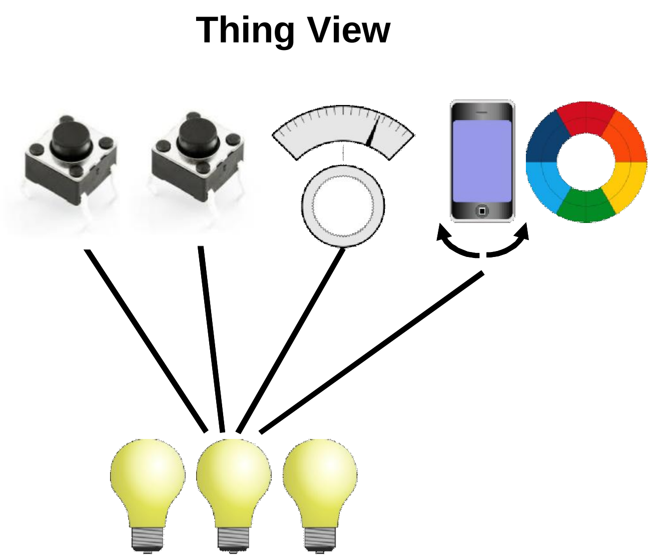
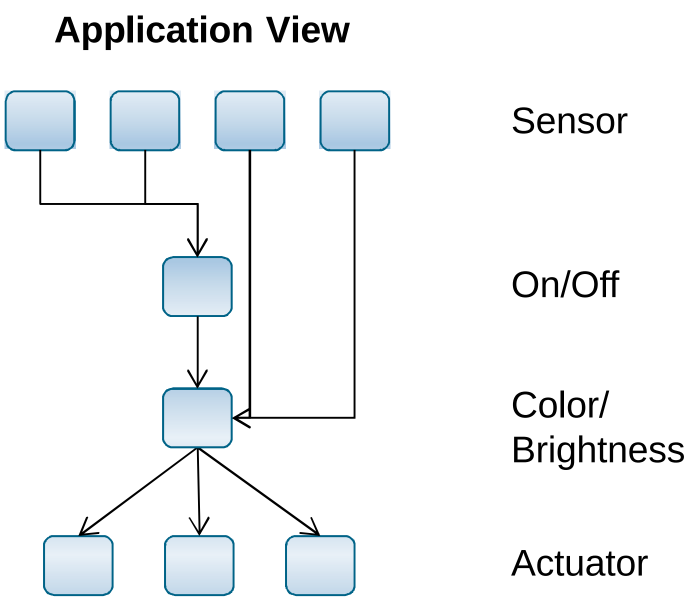
The Application: Single room lighting control, a Things–to–Things interaction





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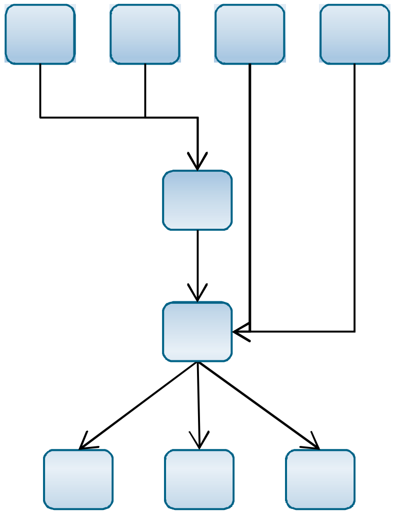
Mapping to REST - Resources

REST Resources	Application View
/sensors/btn	Sensor
/lighting/onOff	On/Off
/lighting/rgb	Color/ Brightness
/lights/rgb	Actuator



That feels “natural”

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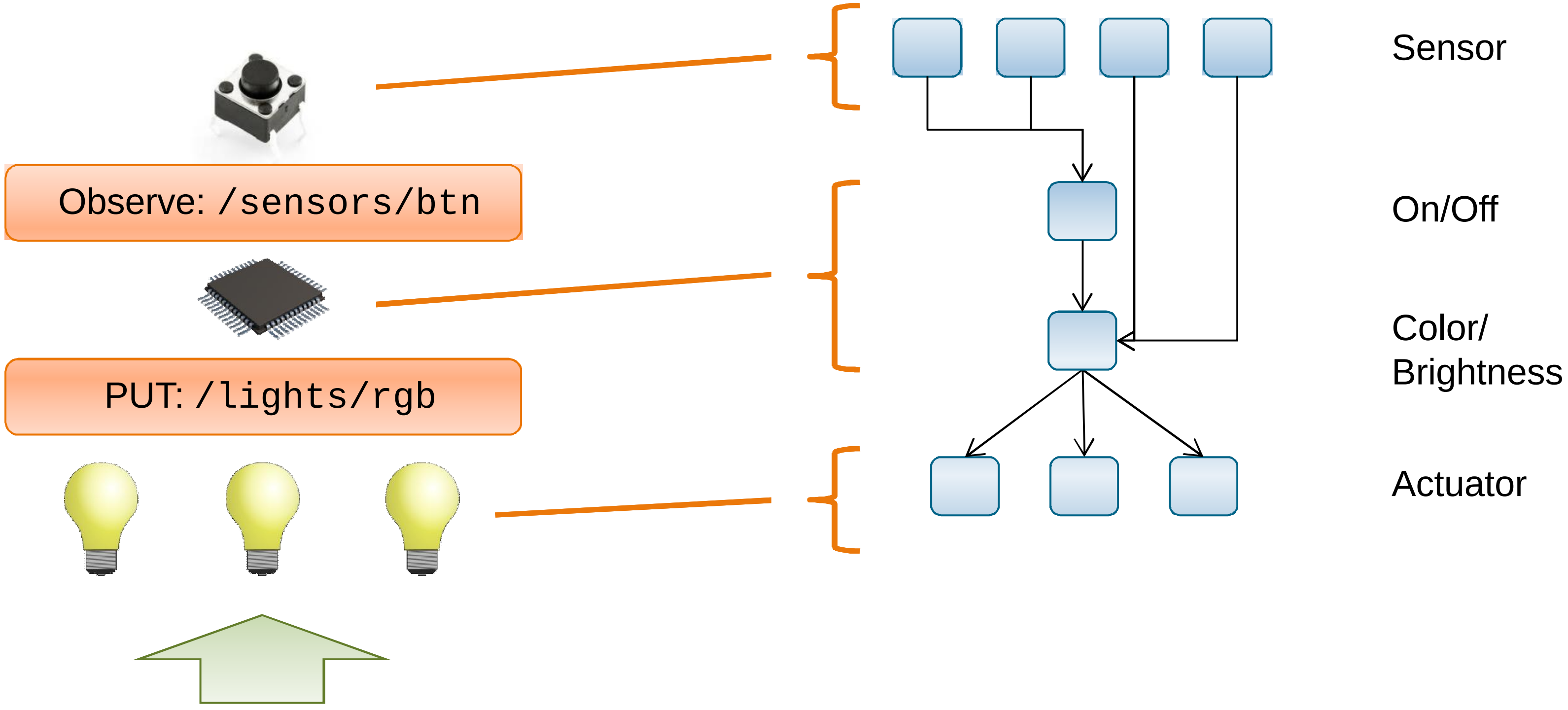
Mapping to REST - Interactions

REST Interactions Try One
“Control Node”

Application View



Observe: `/sensors/btn`

PUT: `/lights/rgb`

Sensor

On/Off

Color/
Brightness

Actuator

That feels “strange”
because its inconsistent

From an automation point of view the data flow between sensor and controller is “the same” as the flow between controller and actuator – why do we have different paradigms?

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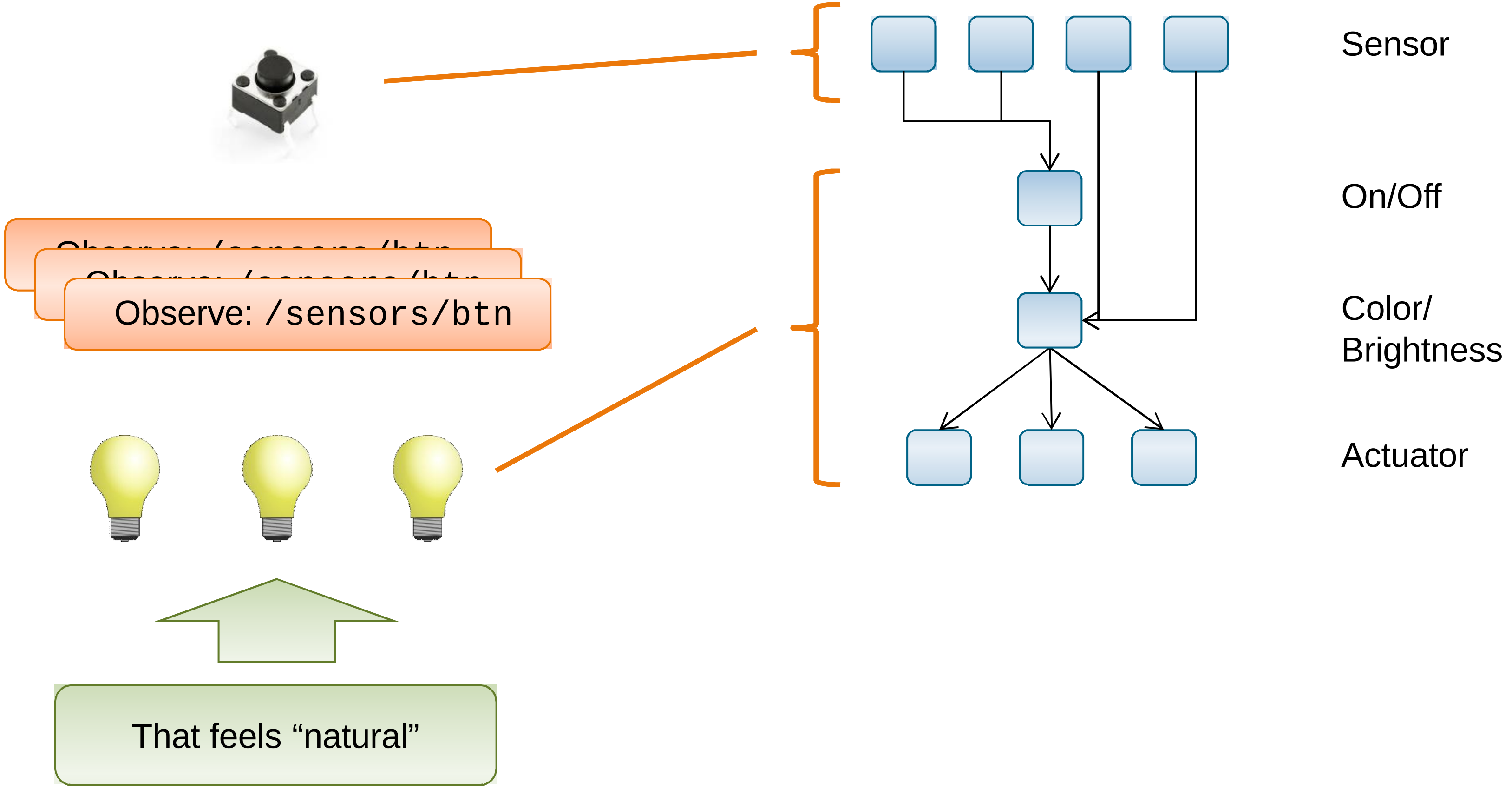
Mapping to REST - Interactions

REST Interactions Try Two
“Dumb Switches, Smart Bulbs”

Application View



Observe: /sensors/btn

That feels “natural”

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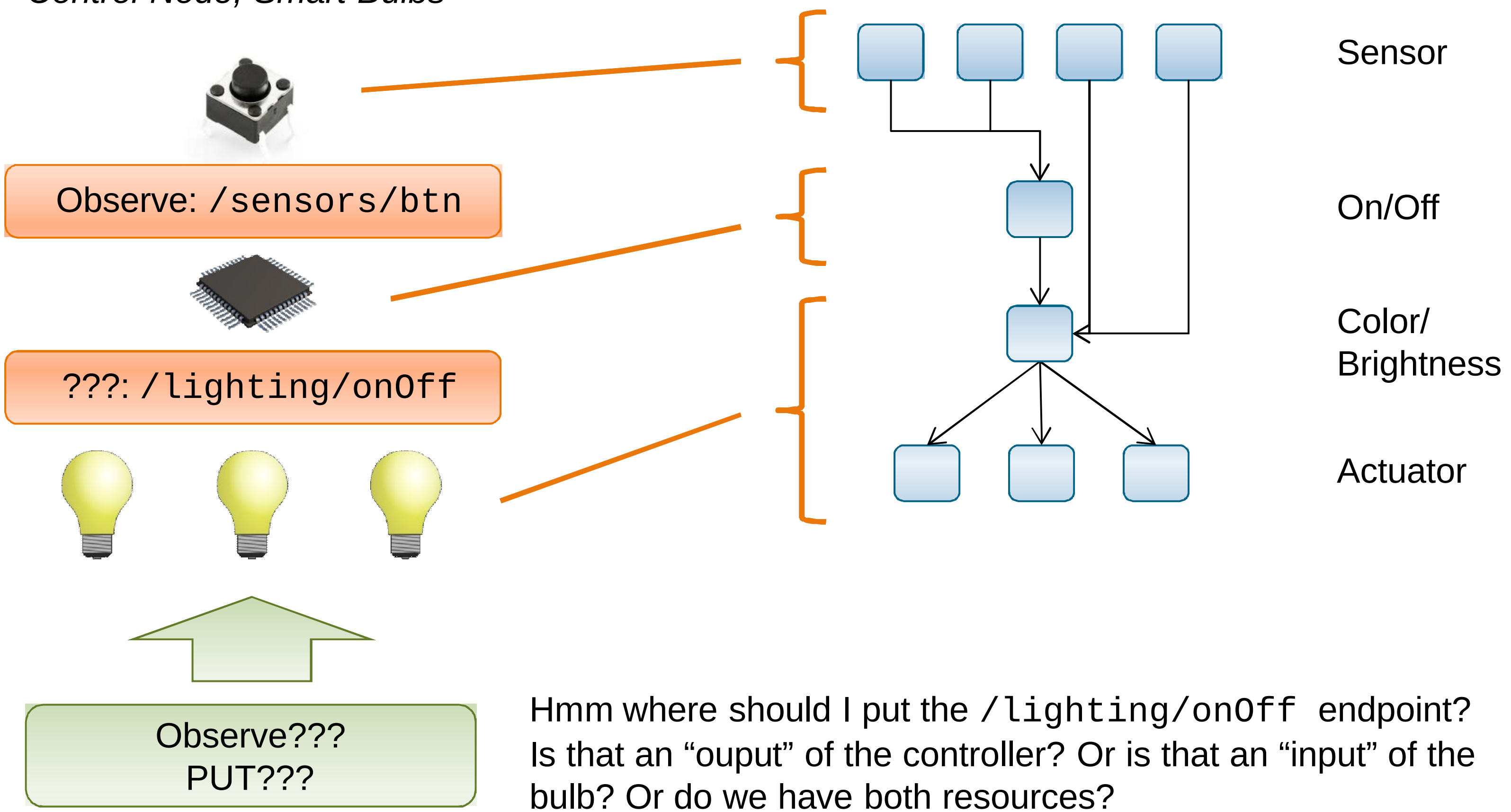
Mapping to REST - Interactions

REST Interactions Try Three
“Control Node, Smart Bulbs”

Application View



Hmm where should I put the `/lighting/onOff` endpoint? Is that an “ouput” of the controller? Or is that an “input” of the bulb? Or do we have both resources?

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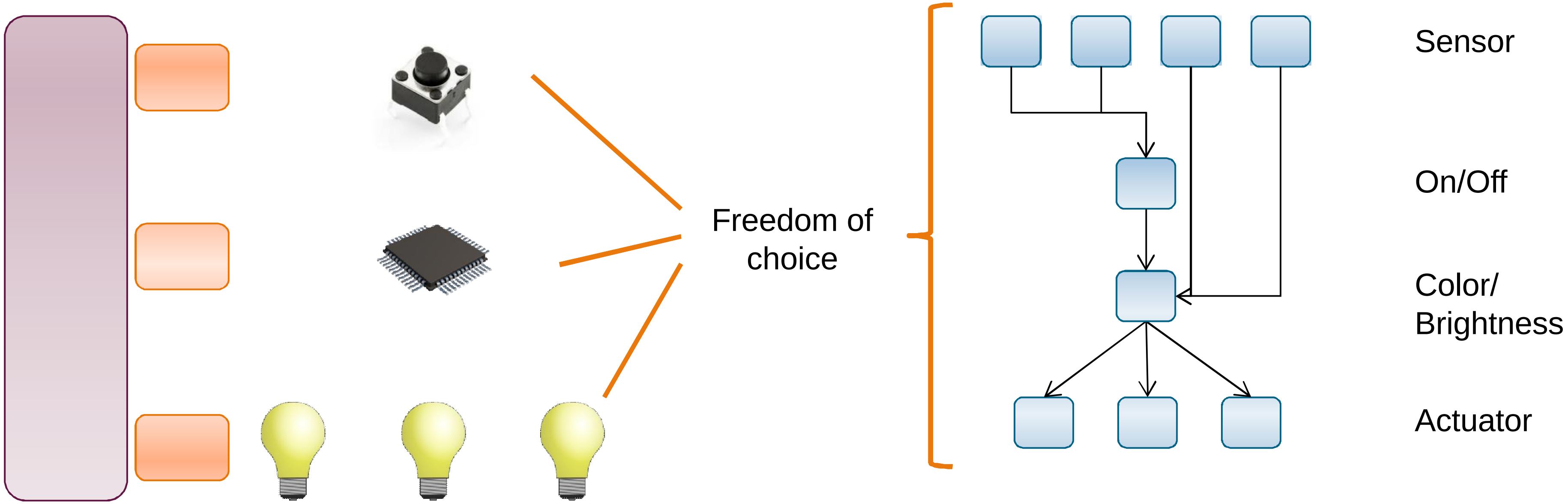
Mapping to REST - Interactions

REST Interactions Try Four
“Pub / Sub”

Application View



CoAP MQ

That feels “natural”
… and like a single point of failure

Abstraction level introduced by CoAP MQ hides the client/server differences

Communication Orchestration?

Looking at CoAP MQ I am wondering whether we can (and should) decouple the role of “communication orchestration” from the role of “data forwarding”

Vision:

- We develop a description format that specifies
  - What resource I am interested in `/sensors/btn`
  - What my interest is consumer of the data
  - What interaction paradigms I like willing to “GET”-poll, observe and being “PUT”-ted
  - Whether I am willing to act as a “data forwarder”
- We introduce an “orchestrator” that
  - Collects these descriptions
  - Determines “suitable” interactions
  - Distributes the results to the devices, which in turn establish the communication channels
- CoAP MQ would be a “special” case of that scenario in which the “orchestrator” is also willing to act as a data forwarder

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Communication Orchestration?

Benefits:

- We could support a broad range of scenarios ranging from decentralized, Thing-to-Thing (switch-to-bulb) over brokered (switch-to-MQ-to-bulb) to a lot more complicated setups with e.g. multiple brokers
- We could leverage existing CoAP interaction paradigms and avoid a layer of “communication middlewares” on top of CoAP that degrade CoAP to a data pipe / rpc mechanism
- We could express interactions that involve multiple resources on different devices (I need the switch and the brightness sensor)
- We could introduce and exploit the capabilities of proxies in a defined way
  - We could add a proxy later on and tell clients to switch over to it
  - We could create “aggregators”/ reverse proxies on demand that collect data from multiple devices and re-publish them under a new resource
- The description format could be extended to support the specification of QoS parameters for the interactions. This might be a promising way to exploit the capabilities provided by software defined networks.

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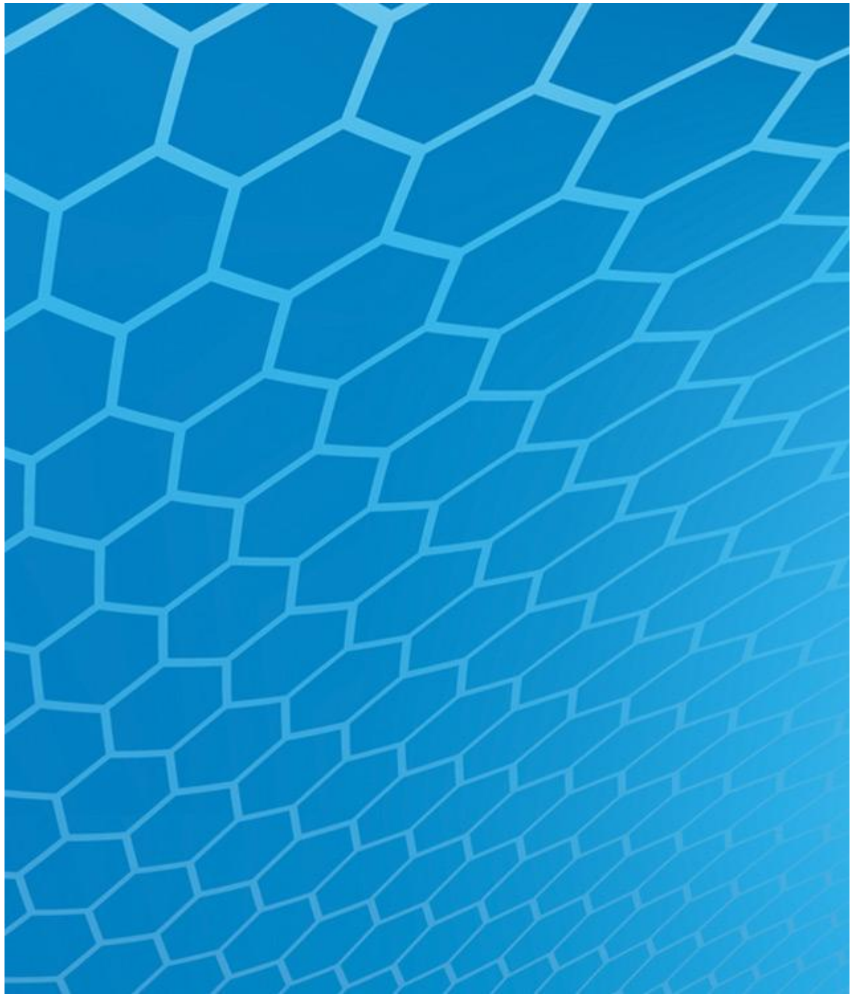

Andreas Scholz
Principal Research Scientist
Siemens CT RTC NEC

E-mail:
andreas.as.scholz@siemens.com