NOKIA Bell Labs

Intent-based networking for OTT applications concepts, lifecycle and challenges

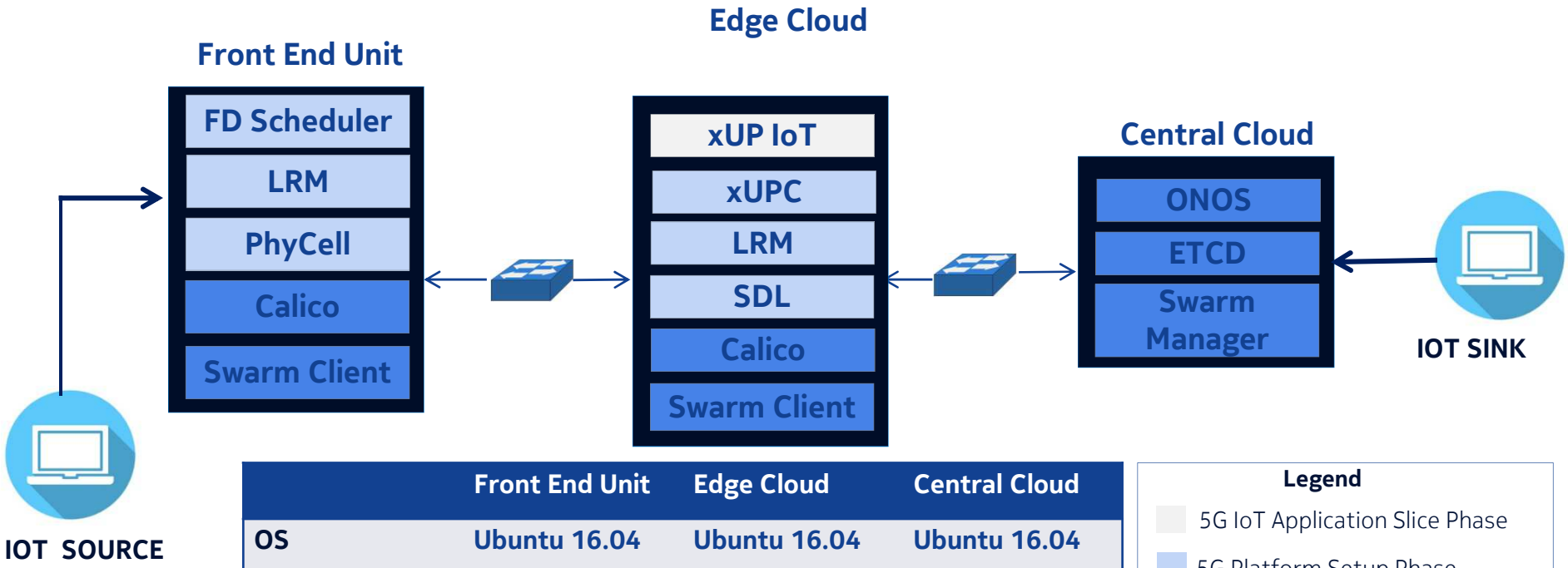
Fred Aklamanu, Sabine Randriamasy

IETF 106 – Singapore - NMRG session1
Thursday 2019/11/21

Presentation Outline

- Context
- Previously presented PoC
- Proposed OTT Intent-Based Networking Framework
- Lifecycle and Challenges

Use-Case : Intent-Based 5G IoT Application Slice on a Cloud RAN



	Front End Unit	Edge Cloud	Central Cloud
OS	Ubuntu 16.04	Ubuntu 16.04	Ubuntu 16.04
RAM (GB)	128	128	16
CPU Cores	24	24	8

Legend

- 5G IoT Application Slice Phase
- 5G Platform Setup Phase
- Virtual Network Setup Phase

Existing research

- Current Intent Frameworks are tailored towards domain experts
  - Knowledge of the network infrastructure is required
- Implementation focuses on network connectivity in fixed networks
- Formal languages for Network Intents are still work in progress.

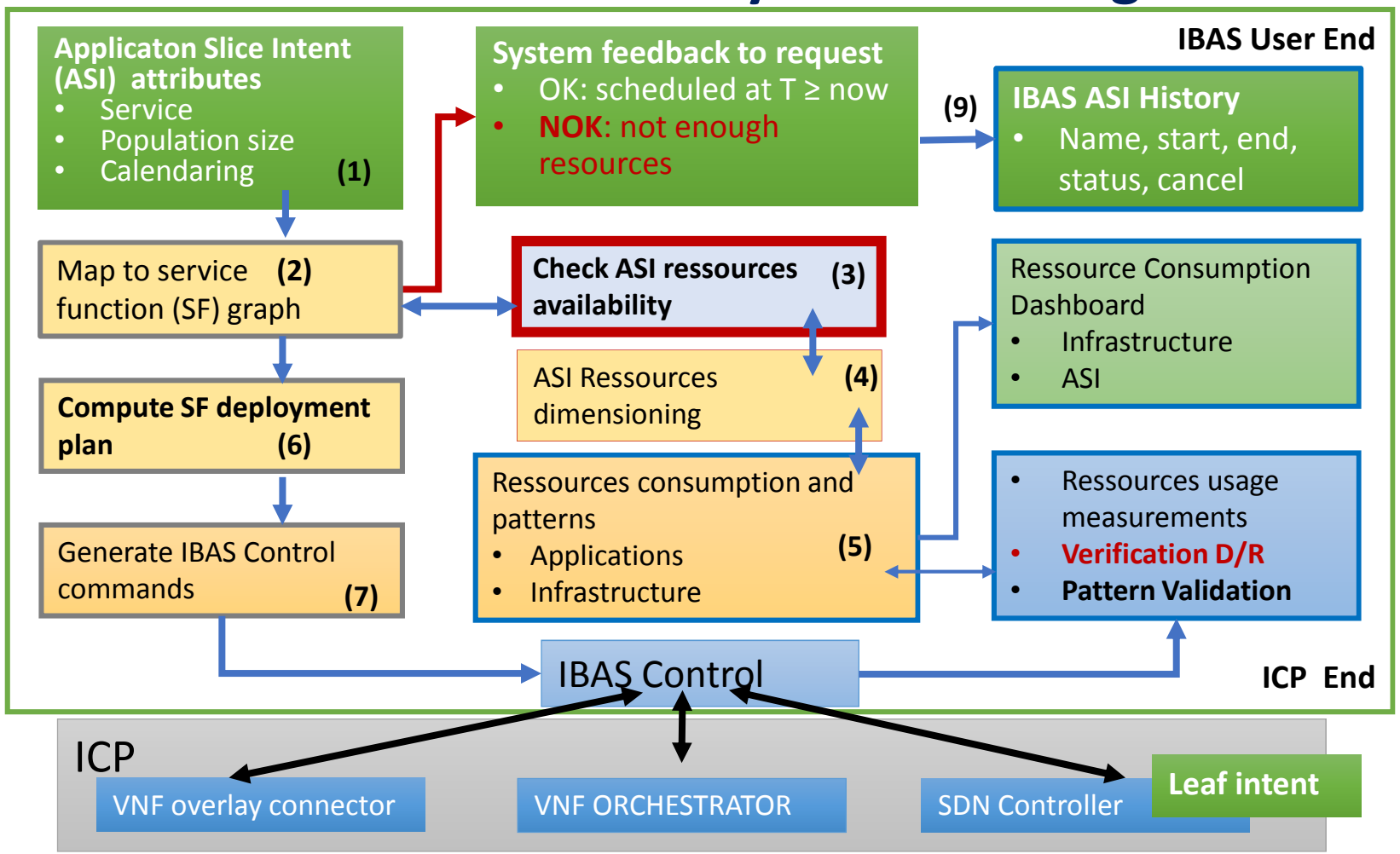
Proposed approach

Extend Intent Based networking

- From connectivity to applications
- From network operation to Over –The-Top (OTT) application provisioning
- From fixed networks to cellular & wireless technology

- **Current focus**
  - Intent request feasibility check and management
  - Intent network application slice automation

OTT IBAS Framework – lifecycle – basic organisation



Example Intent-based request expression with keyfields, parameters, attributes

keyfields = attributes, values = parameters, properties

{

service: IoT-34ABC

sensors: 100, 000

SLA: **{**

bandwidth: [0,1]/small rate

latency: [0,100]/near instant

}

location: Paris – 15e

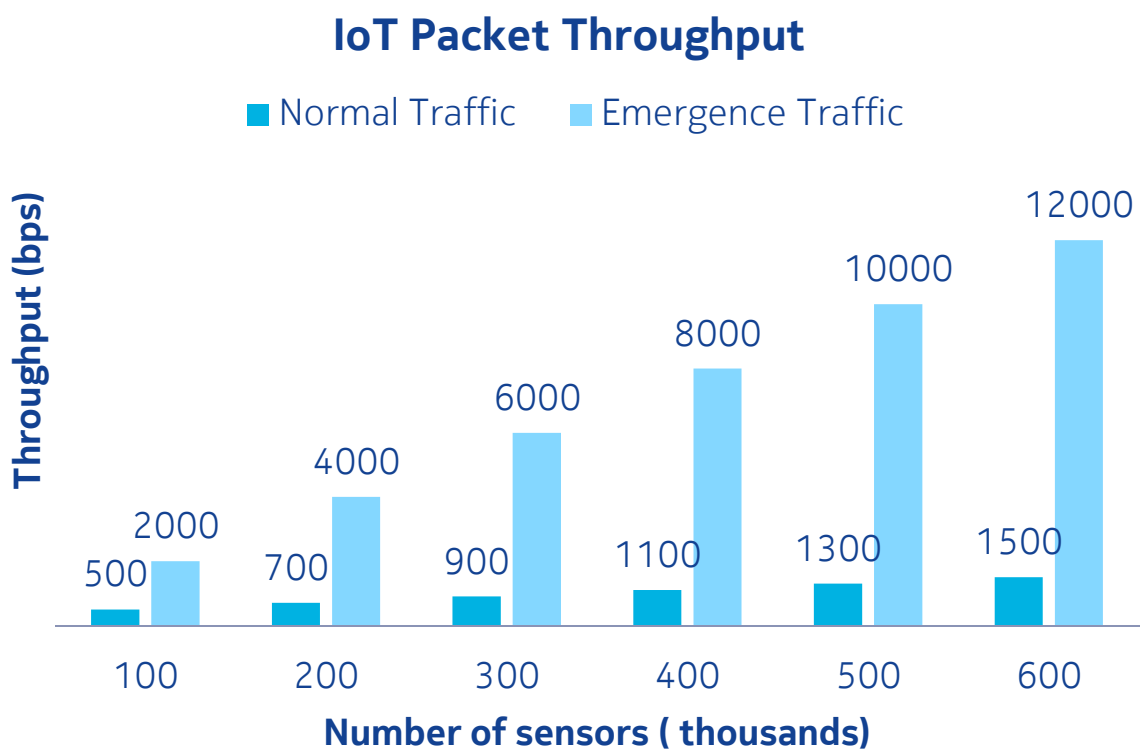
start:11h00

end: 12h00

}

- Basic Intent definition **parameters**
- Intent dimension **parameters**
- Intent performance **parameters**
  Quantitative/qualitative
  User or system specified
- Intent time/space footprint **attributes**

Deployment verification: with 5G IoT Traffic Simulation



✓ **Assurance**

IoT Traffic Attributes

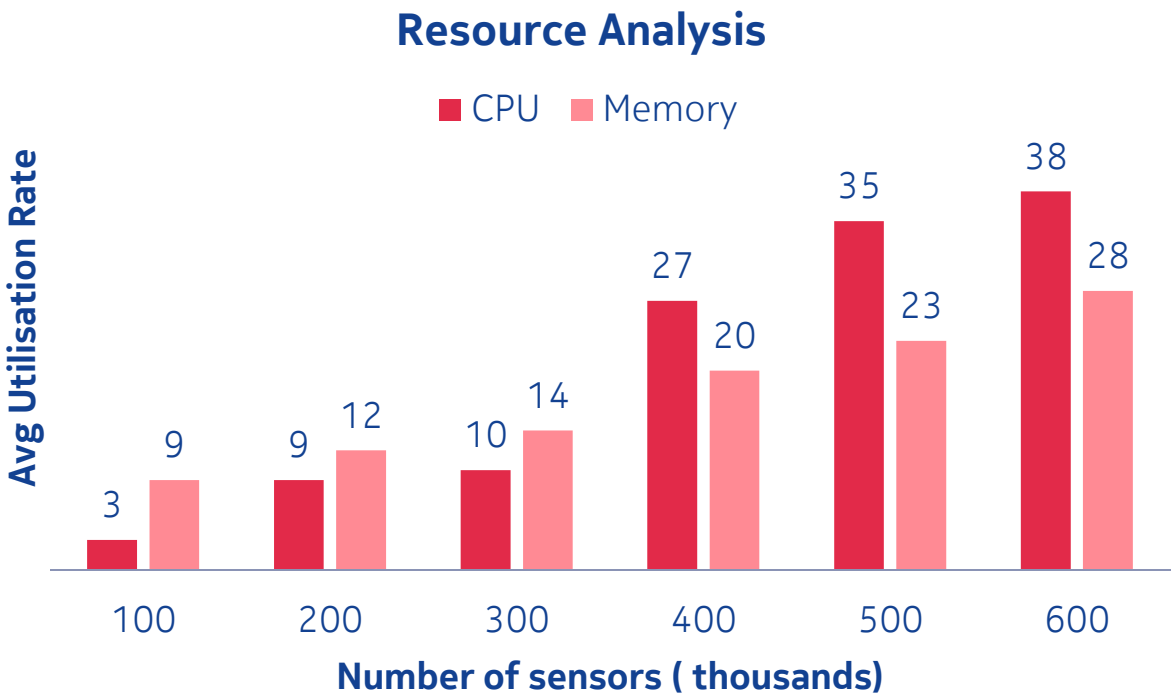
- Packet header 46 bytes
- Payload of less than 120 bytes
- Sensor nodes are static, **NO MOBILITY** considered therefore **NO PACKET COLLISIONS** considered

Results

- **Expected traffic pattern is observed** as traffic sent from source node is received on sink node.

Resources and Monitoring Validation: using 5G IoT Traffic Simulation

Validation of Resource and Intent Monitoring Module



✓ **Assurance**

IoT Slice Resources Attributes

- Dedicated 2 CPU Cores
- Dedicated 1 GB RAM
- Packet header 46 bytes
- Payload of less than 120 bytes
- Sensor nodes are static, **NO MOBILITY** considered therefore **NO PACKET COLLISIONS** considered

Results

- No alarming resource consumption increase is observed
- Observations will refine the intent slice resources dimensioning

Performance Evaluation function of Intent Based Framework

- Confirms deployment and termination of calendered application slice
  - Displays internals of deployment for IBF or specialized user
- Displays Intent-to-run-time delay ➔ health + performance indicator
  - Here: Reduction in network service provisioning time, from hours to minutes

	Number of VNFs	Time (secs)
Virtual Network Setup	**5**	**13**
5G Platform Setup	**7**	**63**
5G IoT App Slice	**1**	**10**
Total	**13**	**86**

- **Specific to IBF**
- **Model should be generic**

First conclusions on basic Intent-Based Framework

- Simpler and faster deployment
  - abstracts network details and complexity from tenants and users
  - speeds-up application slice deployment
- Preventive system feedback ensures feasability of **fullfillment**
  - resources availability check
  - deployment check
- On-line measurements to monitor Intents
  - verify that traffic is flowing according to specified pattern (**assurance**)
  - in/validate resources dimensioning
  - expose resources consumption for reliable billing

Challenges

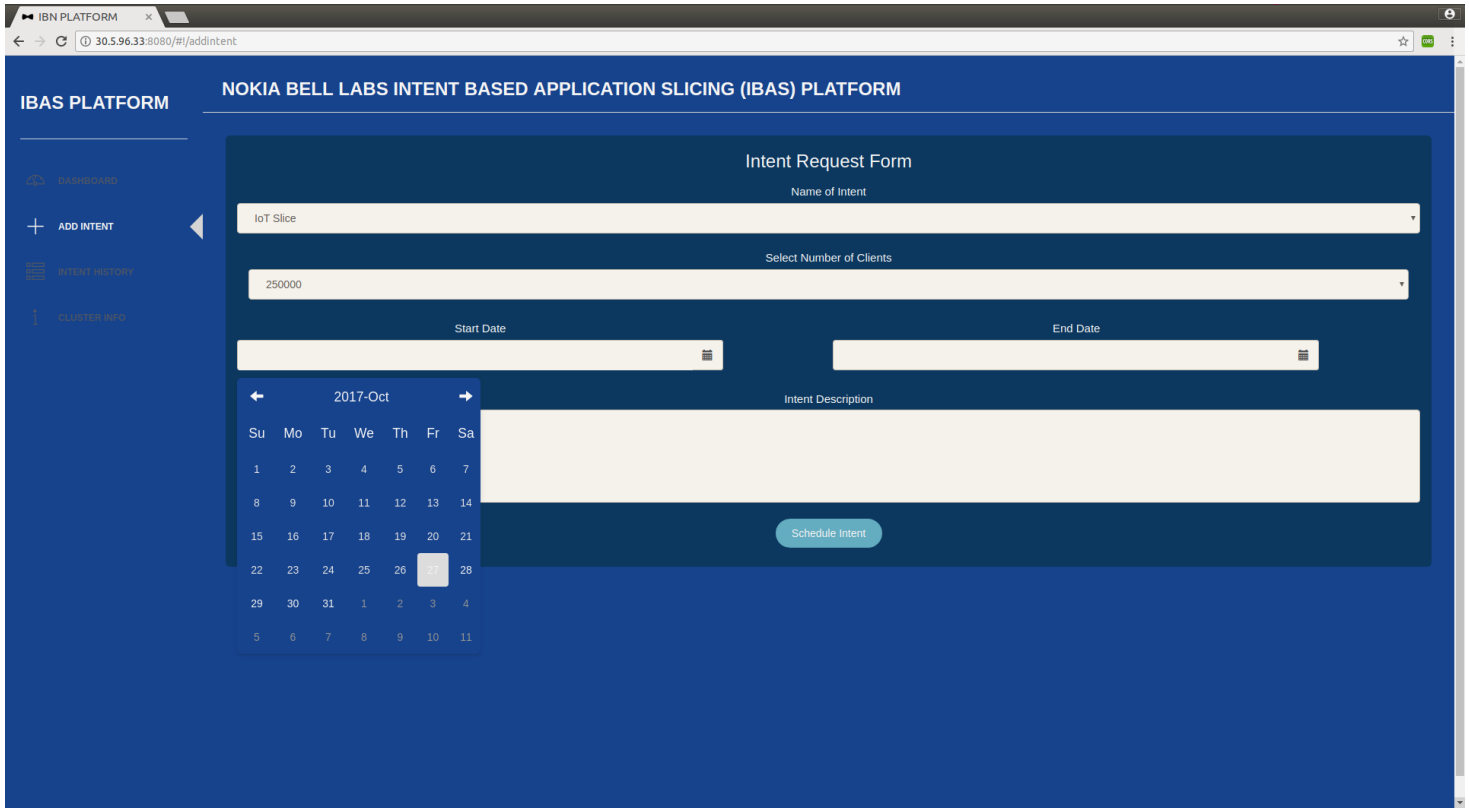
- OTT slices may span several domains (technology and/or admin)
- applications need end to end deployment and lifecycle management
- « real life » IBN frameworks may be composed of several basic frameworks
- A basic intent framework framework may interact with a variety of
    - Infrastructure controller implementations
    - Other intent frameworks
- Formal model for Network Applications Intents: parametric
    - wat can be made re-usable?
- Intents realize various services at different layers
- An intent framework should be specialized
    - wrt e.g. : location, technology, admin. domain
    - what **Classification** parameters? Which ones are re-usable
- Specialized Intent definition topology abstraction model
- Formal model for in-line intent evaluation

Thank you for your attention

References

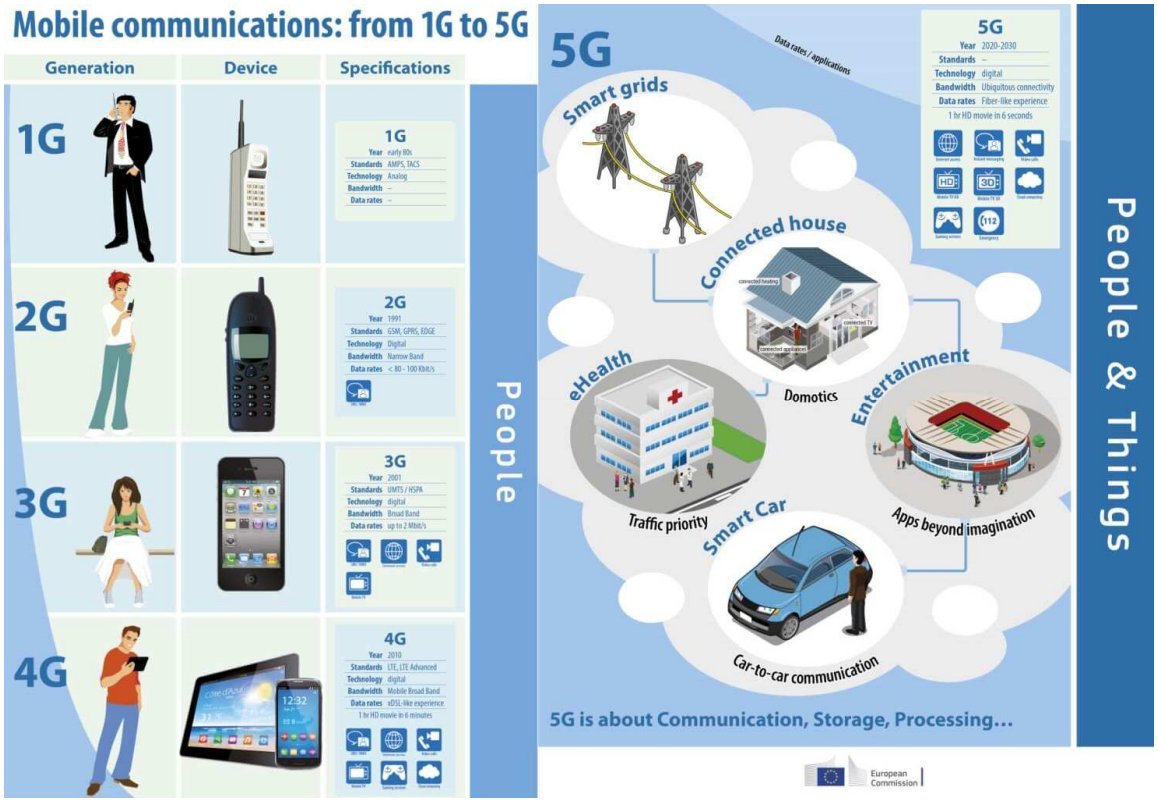
1. F. Aklamanu, S. Randriamasy, E. Renault, I. Latif, A. Hebbar: “Intent-Based Real-Time 5G Cloud Service Provisioning”. 2018 IEEE GLOBECOM Global Communications Conference, December 2018
2. Fred Aklamanu, Sabine Randriamasy, Eric Renault, *Intent-Based 5G IoT Application Network Slice Deployment,* 10th International Conference on Networks of the Future (NoF), Special Joint NMRG - NoF Demo Session on Intent-Based Networking - Oct 2019.
3. Fred Aklamanu, Sabine Randriamasy, Eric Renault, "Utility and A*-based Algorithm for network slice placement and chaining ", to appear at IEEE Globecom, Dec. 2019

Intent Request Form



NOKIA Bell Labs

Motivation



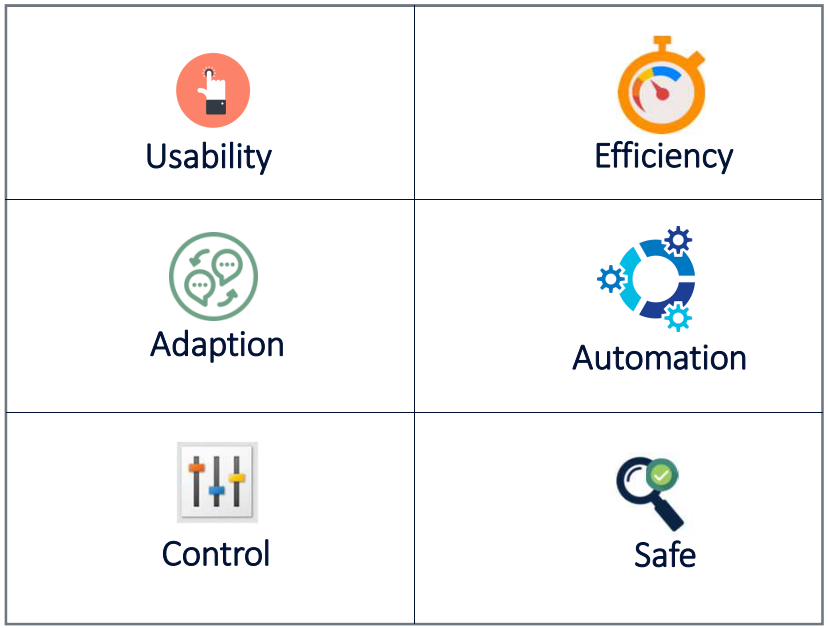
- Network Infrastructure Complexity
- Multi-vendor equipments
- Network Management Issues
- One size cannot fit all

  (Network Slicing)
- Complexity in network slice life cycle management

Source: https://www.broadbandgenie.co.uk/features/5g-future-mobile-broadband

What is Intent-Based Networking?

Tell me **WHAT** to do not **HOW** to do it



Source: ETSI Summit 5G Network Infrastructure

State-of-The-Art Highlights

Implementation

- Open Network Operating System (ONOS) Intent Framework
  - > *add-host-intent host-id1 hostid2*
  - > *add-port-intent switchId/InPort switchId/Outport*
- Network Intent Composition (NIC) OpenDay Light
  - > *intent:add -a ALLOW -t 00:00:00:00:00:01 -f 00:00:00:00:00:02 -q QOS -p High_Quality*

- NEtwork MOdeling Language (Nemo)
  - > *node user01 type logicnw user01*
  - > *flow dcinternet match IPv4src:list(10.1.1.0/24) match IPv4dst:list(10.1.1.0/24)*

Publication

Intent-based Cloud service management

S. H. Wu Chao, "Intent-based cloud service management," in 21st Innovation in Clouds, Internet and Networks. IEEE, 2018.

- Focuses on resource allocation for cloud services
- Allows users to specify their service-layer requirements in a language natural i.e user-friendly way.

State-of-The-Art Highlights

4th Generational Languages (4GL)

•Aims to provide a higher level of abstraction

• 4GL is subset of Domain Specific Languages (DSL).

• 4GL may include support for database management, report generation, mathematical optimization, GUI development, or web development

Why a deep dive into 4GL

• Representation model for intents

• A possible language for Intent expression

State-of-The-Art Highlights

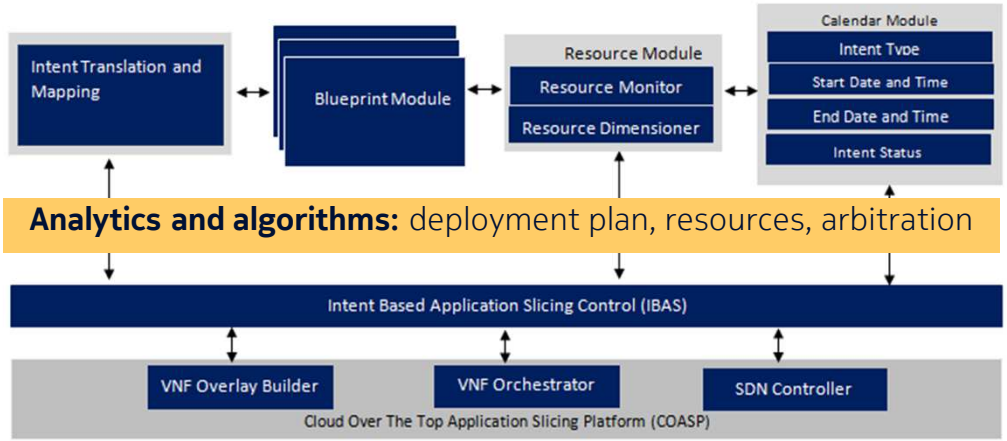
Transformational Languages

1. Spoon (Java) -> Tailored towards java only thus Intents need to expressed in java
2. C Intermediate Language (C) -> Target programs/ code should in C
3. Coccinelle (C) -> Target programs/ code should in C
4. Stratego/XT (Lex and Yacc) -> It can also serve the purpose of language transformation but all lexicals need to be defined by the user
5. **Turing eXtender Language (TXL) -> Generic thus a potential candidat e for language transformation it provides a pre-defined lexical library that can be extended**

Take-away

- Standardised Intent Language and expression are a must (domain specific languages)
- Intent decomposition into various domains

OTT IBN Framework - deployment cycle - coarse



- **Analytics and algorithms**

Abstract infrastructure topology and parameters

Support to user specification of intent footprint

Computes VNF deployment plan, adapts consumption models

- **Intent Based Application Slicing Control Module**

Central hub for communication between underlying physical network infrastructure Controllers and the IBN Modules.

Gets relevant information on underlying infrastructure

- **Intent Translation and Mapping: Intent Request Interface to Network User (Function)**

Gets Network User request (Intents) parameters

Maps them to Blueprint DB search parameters

- **BluePrint Module**

Repository for Network Service Template

VNF directed graphs + initial VNF profile

- **Resource Module**

Monitors resource consumption of Cloud + VNF chain

Dimensions Intent resources: Cloud + Network

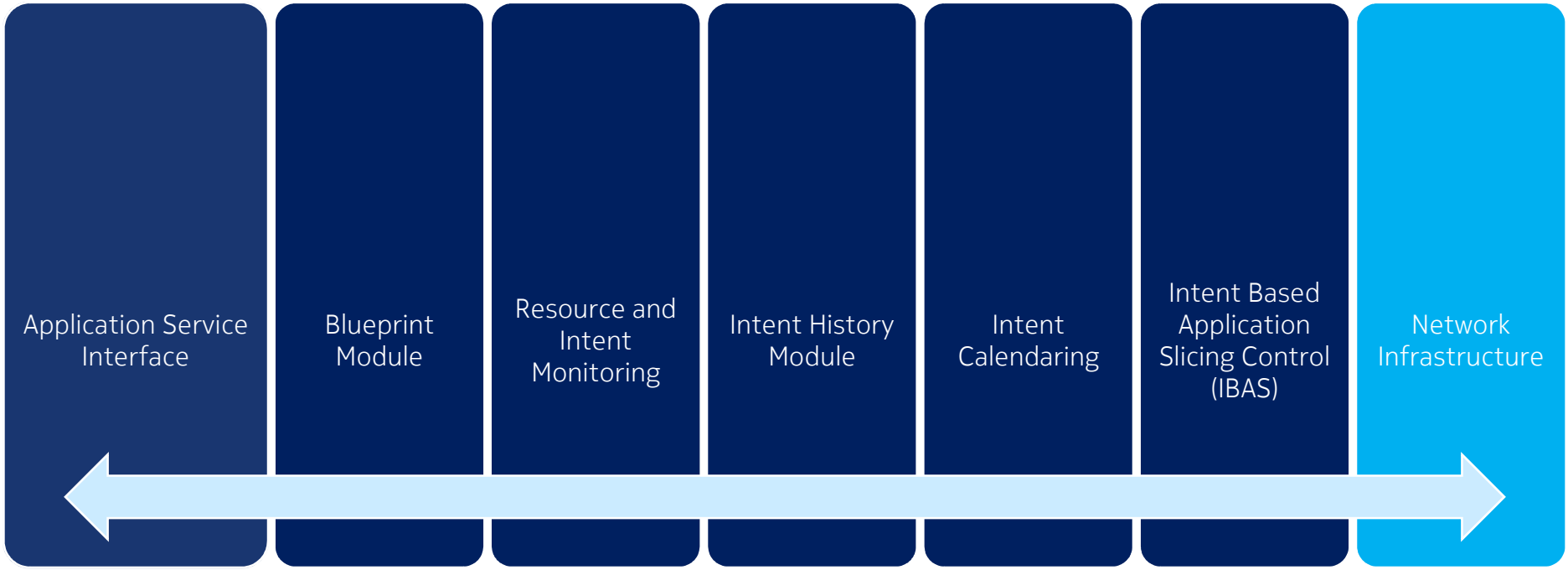
Checks resources availability

- **Intent Calendaring Module**

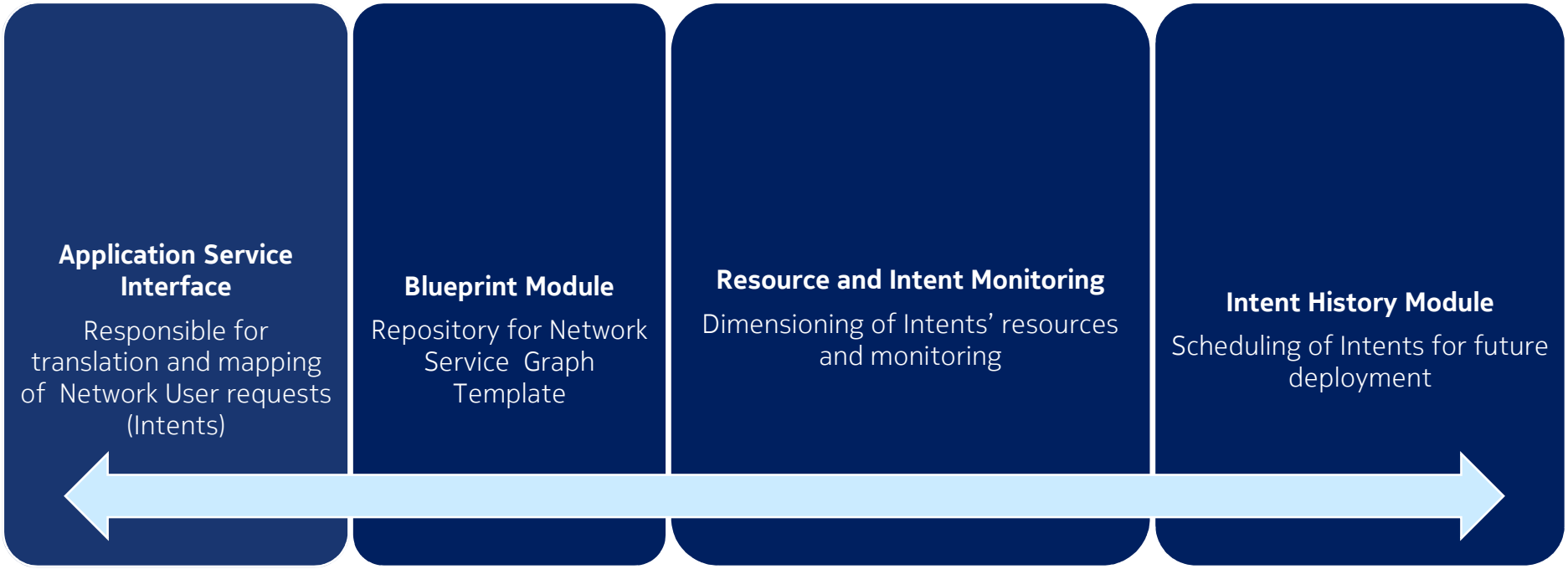
Schedules Intents for automatic future deployment

NOKIA Bell Labs

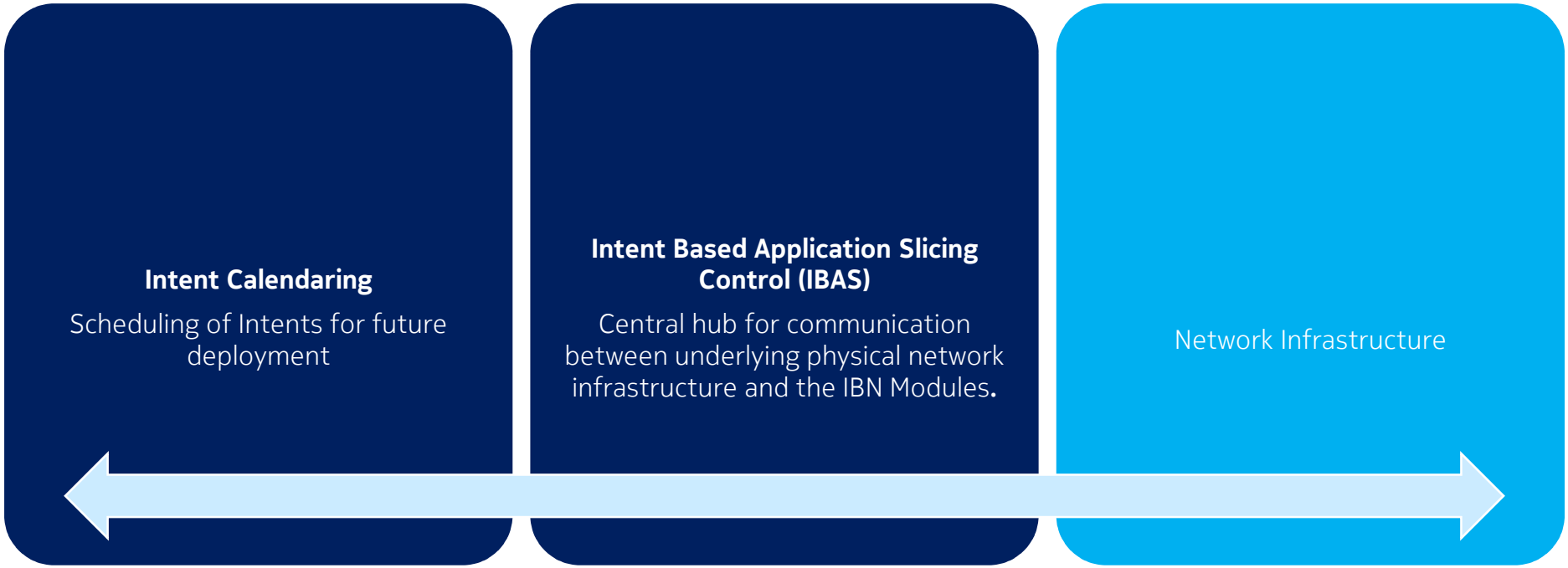
Proposed Intent Based Networking Framework



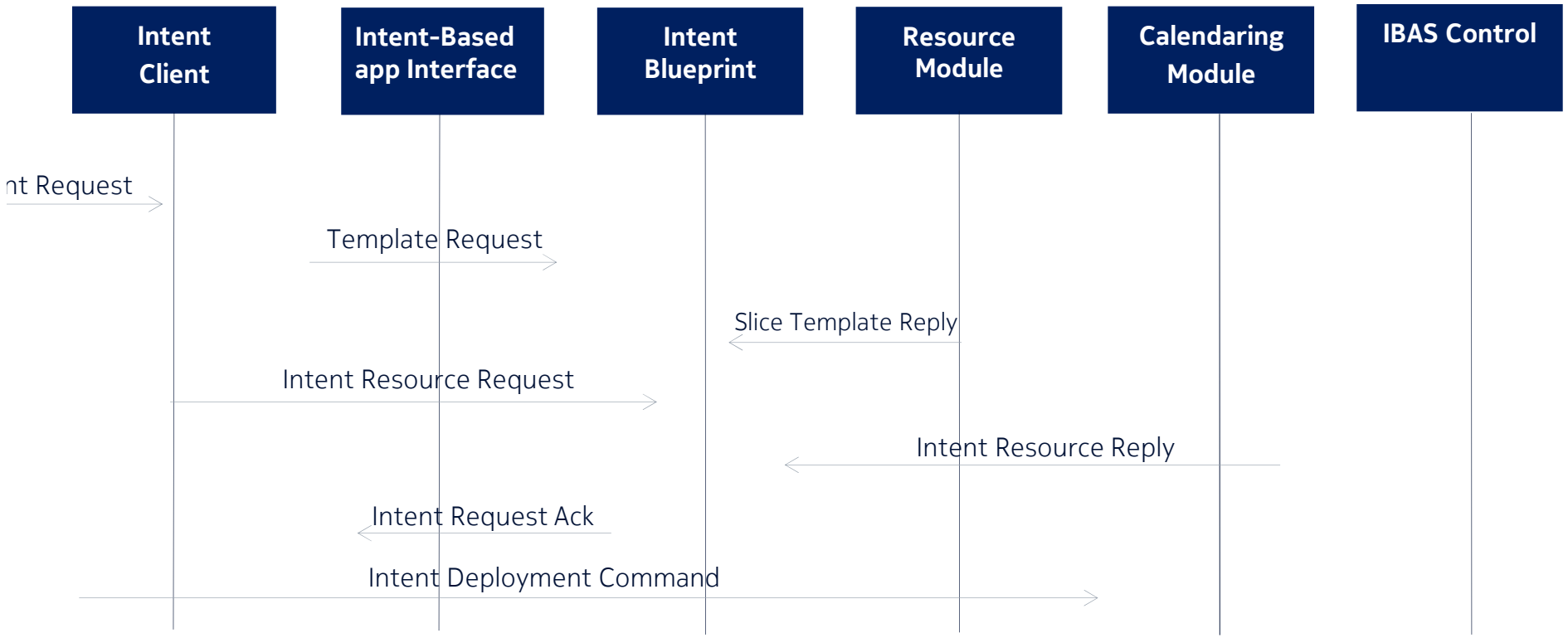
Proposed Intent Based Networking Framework
Modules



Proposed Intent Based Networking Framework
Modules



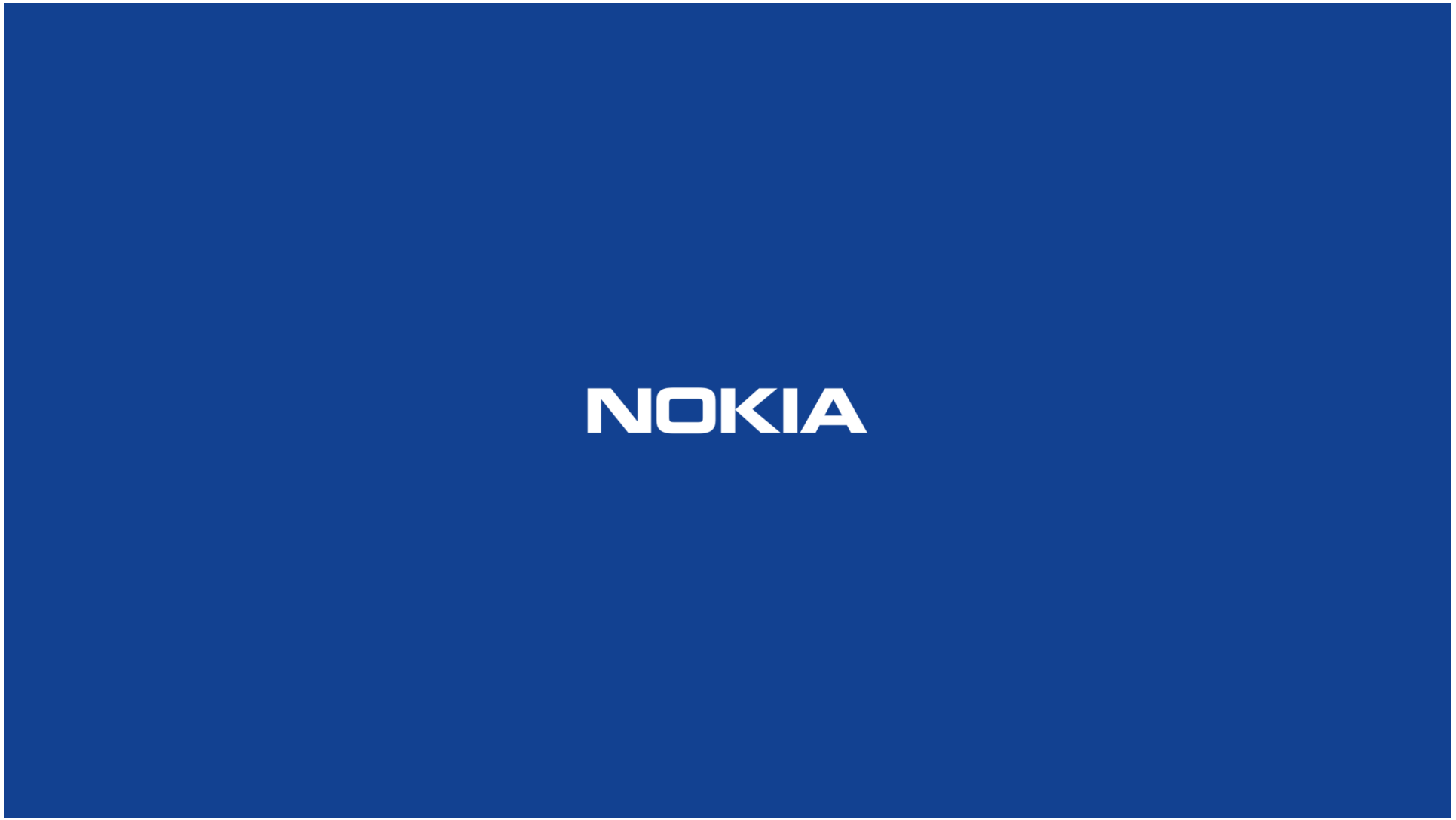
Intent Deployment Process Flow



Example of mapped Service Graph Template (Blueprint)

```
{
   service: IoT
   components: [ VNF1, VNF2, VNF3 VNF4, VNF5]
}
```

NB: components configuration are stored in a DB


NOKIA