NOKIA Bell Labs

Intent-Based 5G IoT Application Network Slice Deployment

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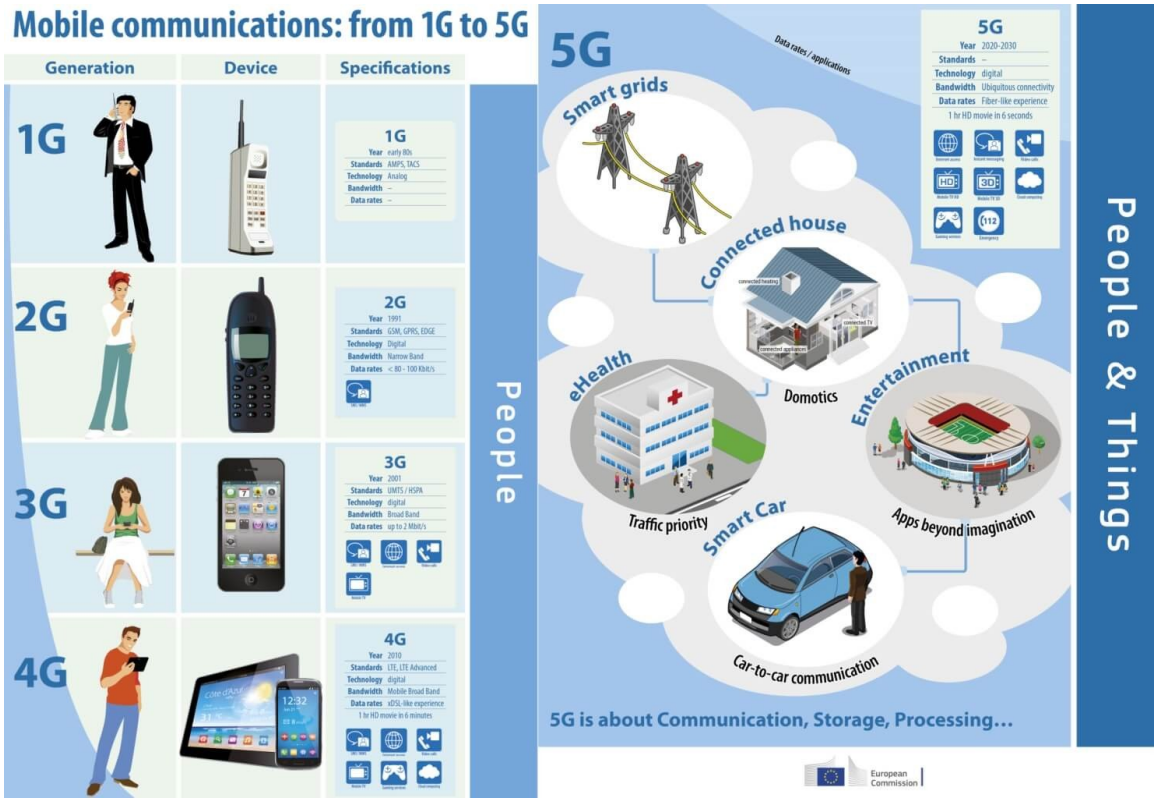
Presentation Outline

- Motivation
- State-of-The-Art
- Proposed Intent-Based Networking Framework
- DEMO
- Evaluation and Conclusion
- Perspectives

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

 Usabilit y	 Efficienc y
 Adaption	 Automation
 Control	 Safe

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 into 4GL

• Representation model/format/language

State-of-The-Art Highlights

Transformational Languages

- Spoon (Java)
- C Intermediate Language (C)
- Coccinelle (C)
- Stratego/XT (Lex and Yacc)
- **Turing eXtender Language (TXL)**

Take-aways

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

Research Problems

- 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.

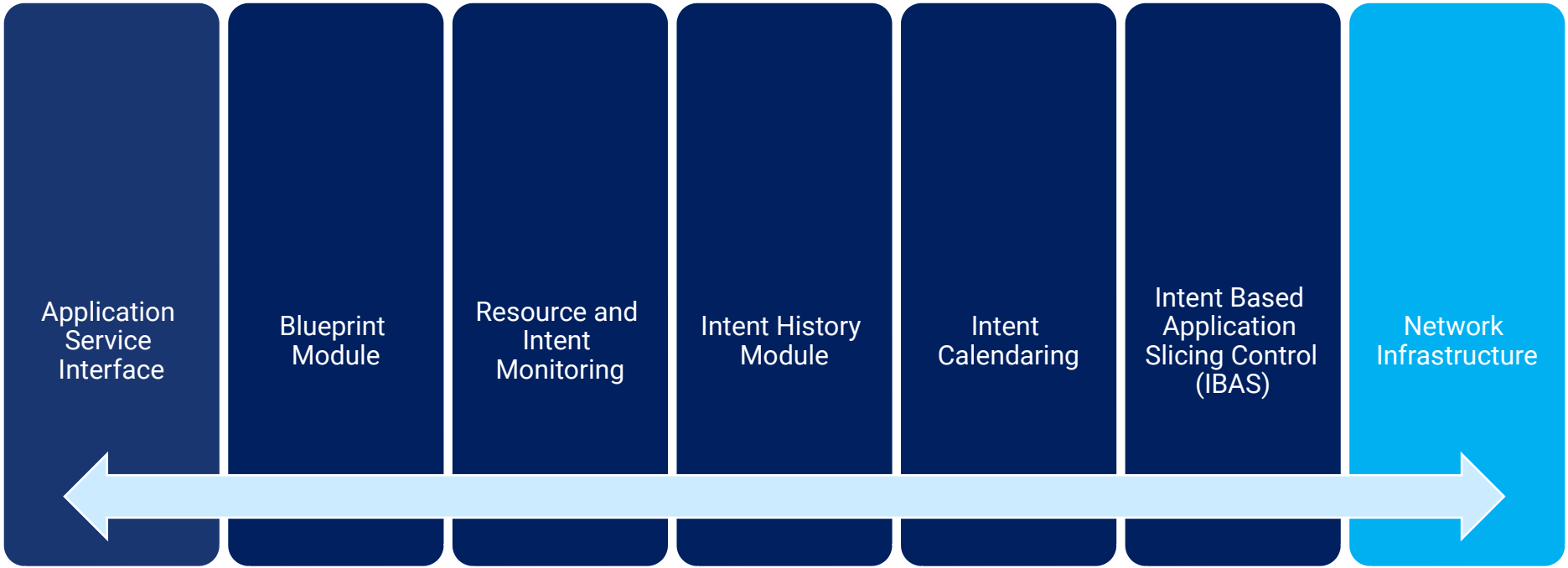
Proposed approach

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

Proposed Intent Based Networking Framework



Intent Based Networking Framework Modules

- **Intent-Based Application Service Interface**
  Responsible for translation and mapping of Network User requests (Intents)

- **Service BluePrint**
  Repository for Network Service Template

- **Resource and Intent Monitoring**
  Dimensioning of Intents' resources and monitoring

- **Intent Calendaring**
  Scheduling of Intents for future deployment

Intent Based Networking Framework Modules

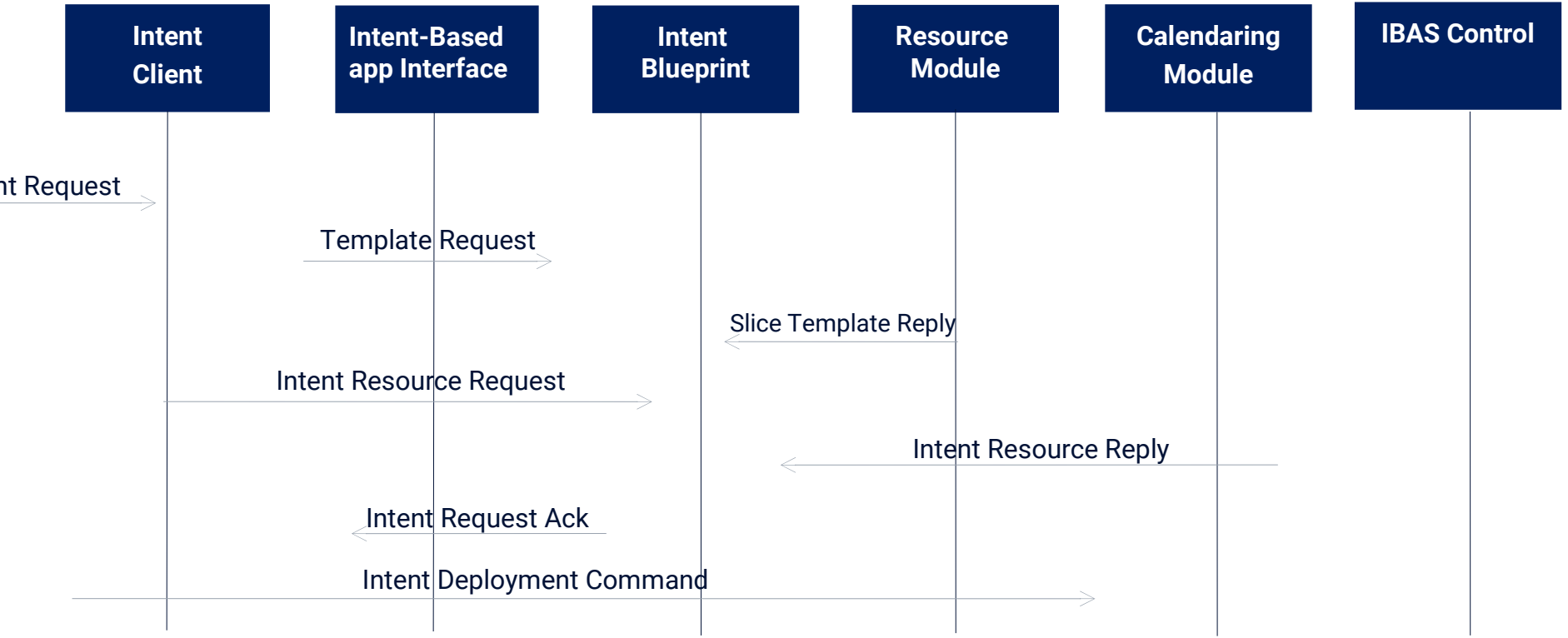
- **Intent History**

Tracks network user Intent behavior for analytics purposes.

- **Intent Based Application Slicing Control Module**

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

Intent Deployment Process Flow



Example of Intent-based request expression

```
{
   service: IoT
   sensors: 100, 000
   SLA: {
            bandwidth: 1
            latency: 100
      }
    location: 15e Paris
    start:11h00
    end: 12h00
}
```

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

Example of mapped Service Graph Template (Blueprint)

{

service: IoT

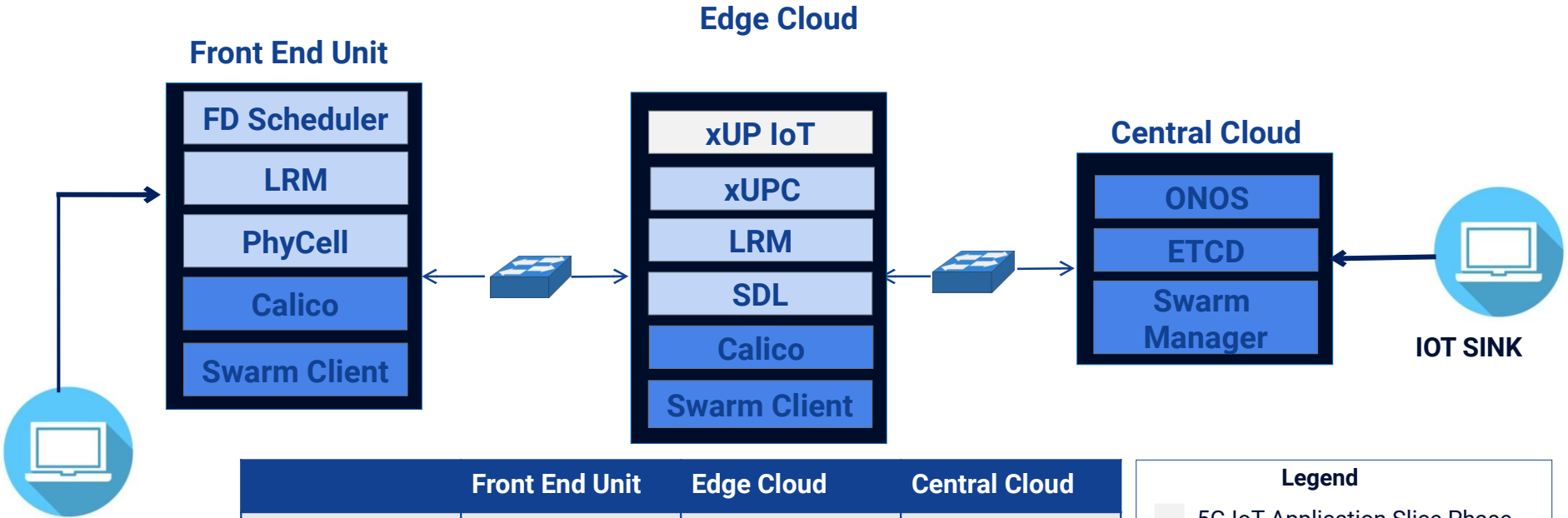
components: [VNF1, VNF2, VNF3 VNF4, VNF5]

}

NB: components configuration are stored in a DB

DEMO

Use-Case : Intent-Based 5G IoT Application Slice

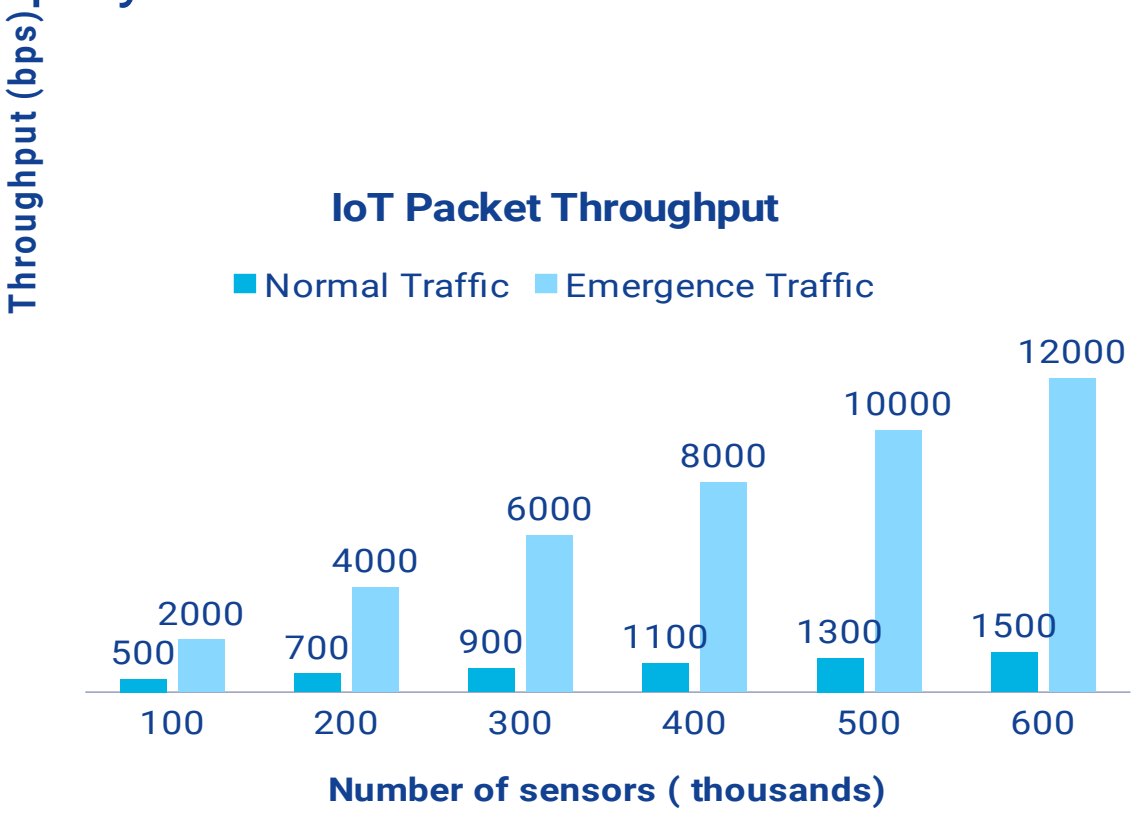


	Front End Unit	Edge Cloud	Central Cloud
OS	Ubuntu 16.04	Ubuntu 16.04	Ubuntu 16.04
RAM (GB)	128	128	16
CPU Cores	24	24	8

Legend

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

Deployment verification: with 5G IoT Traffic Simulation



IoT Traffic Attributes

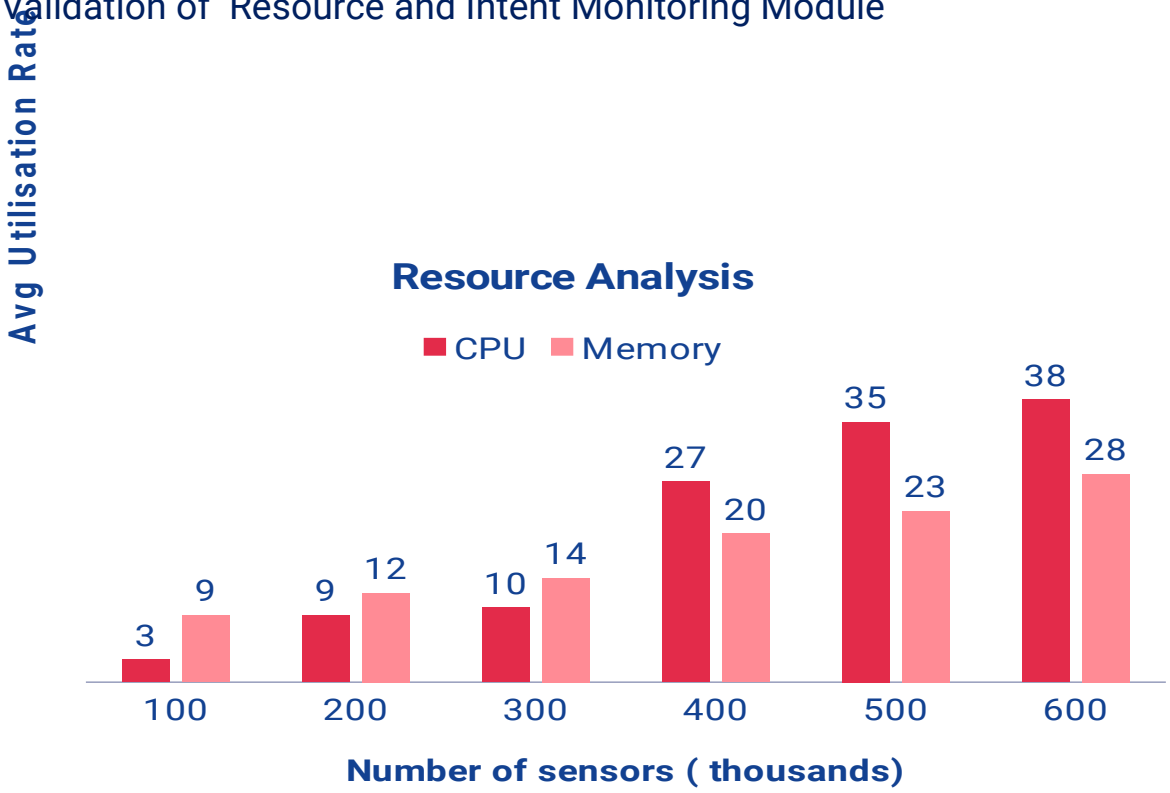
- Packet header 46 bytes
- Payload of less than 120 bytes
- Sensor nodes are static, **NO MOBILITY** considered therefore **NO PACKET COLLISIONS** considered

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



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 of Intent Based deployment framework

- Validation of automation efficiency
- Automatic deployment and termination of calendered application slice.
- From service request to system feedback
- 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**

Conclusion

- Intent-Based Networking approach abstracts network specificities from network tenants and infrastructure owners or operators.
- The proposed Intent-Based Framework manages the lifecycle of Intents to maintain network tenants' requests.
- Simulation of sensor traffic on the 5G IoT application slice shows no alarming impact on network resources despite different traffic profiles

Perspectives

- Formal model for Network Applications Intents
  - semantics
  - domain specific parser
- Formal model for Intent operational evaluation
- Adaptive learning approach for « Intent Engine »

Thank you for your attention

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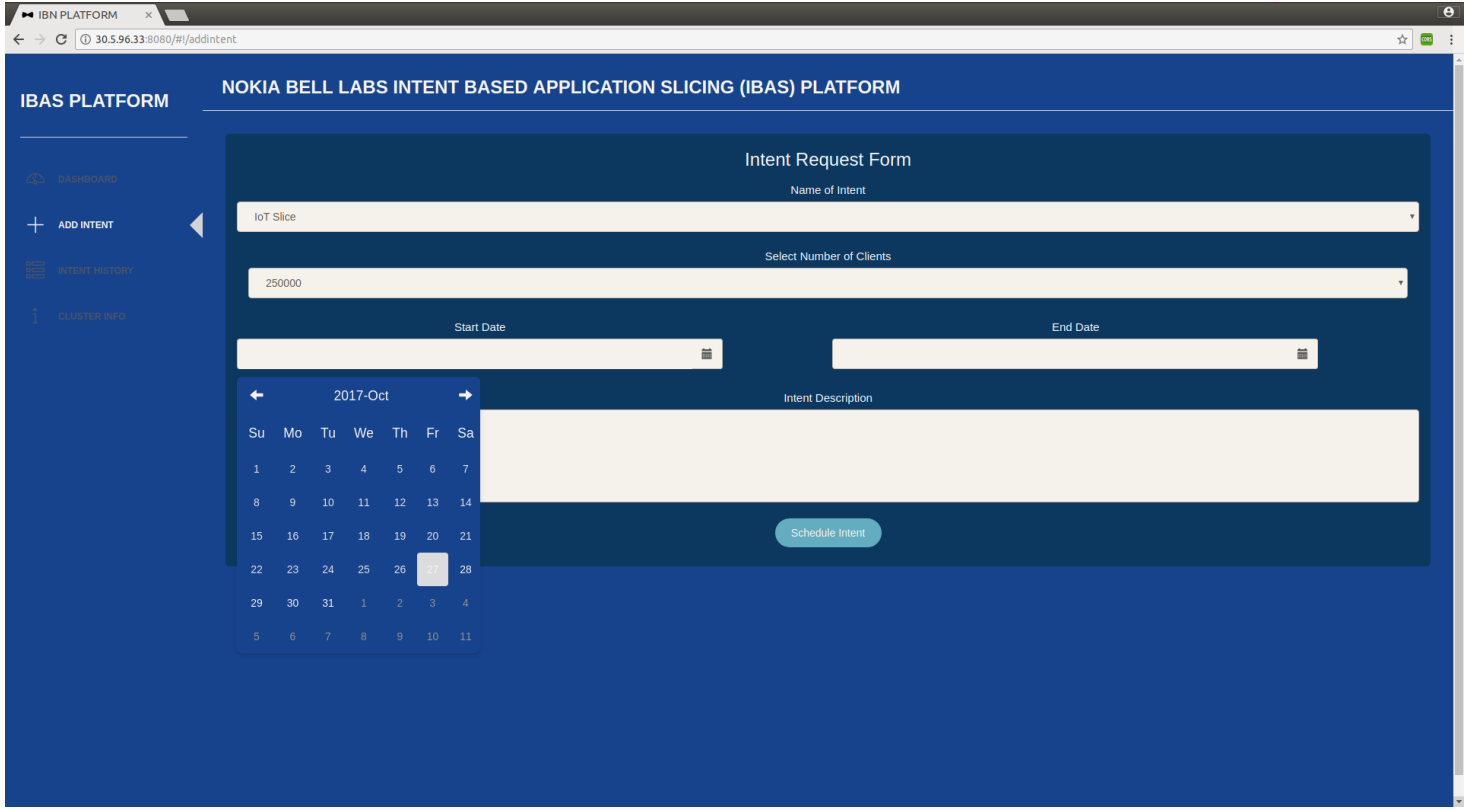
Intent Request Form



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