



# Resilience & 5G

*SOME CONTROL & LIABILITIES ISSUES*

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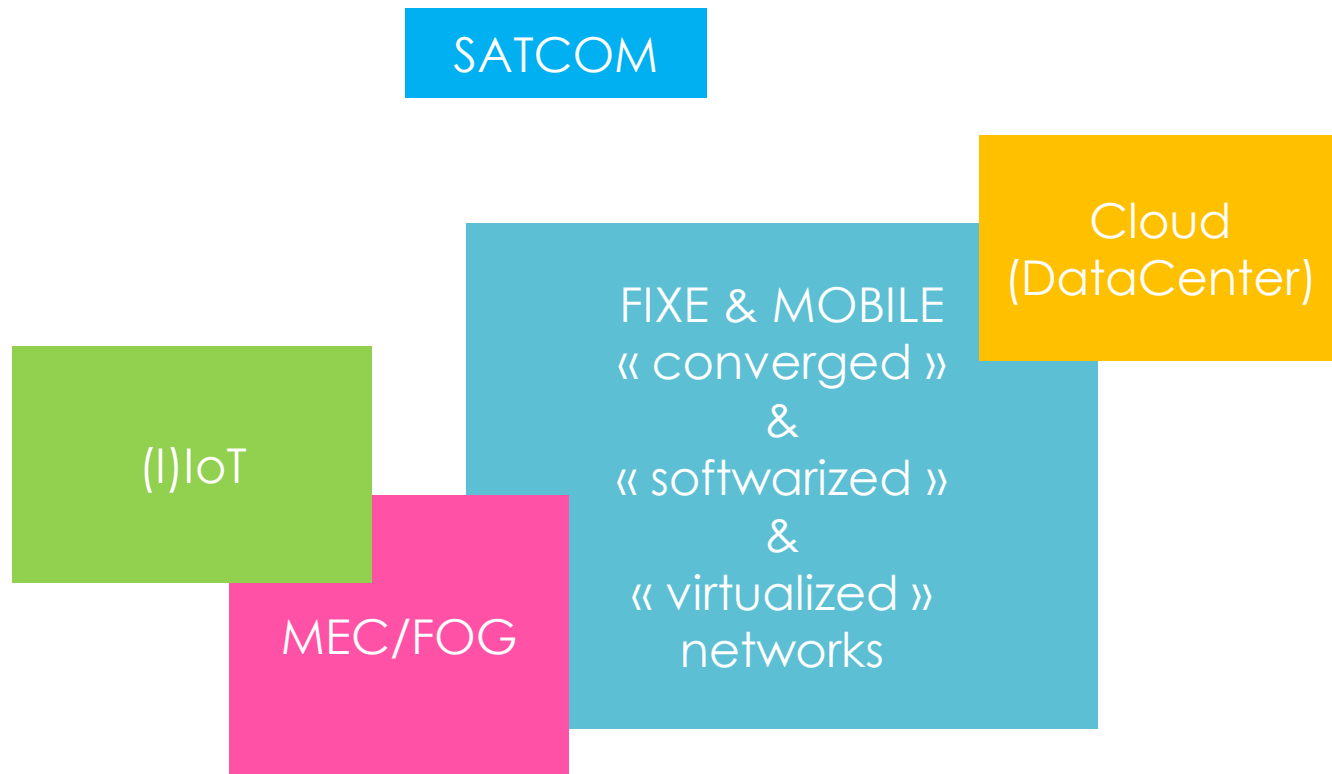


## ■ No claim for a definitive 5G vision

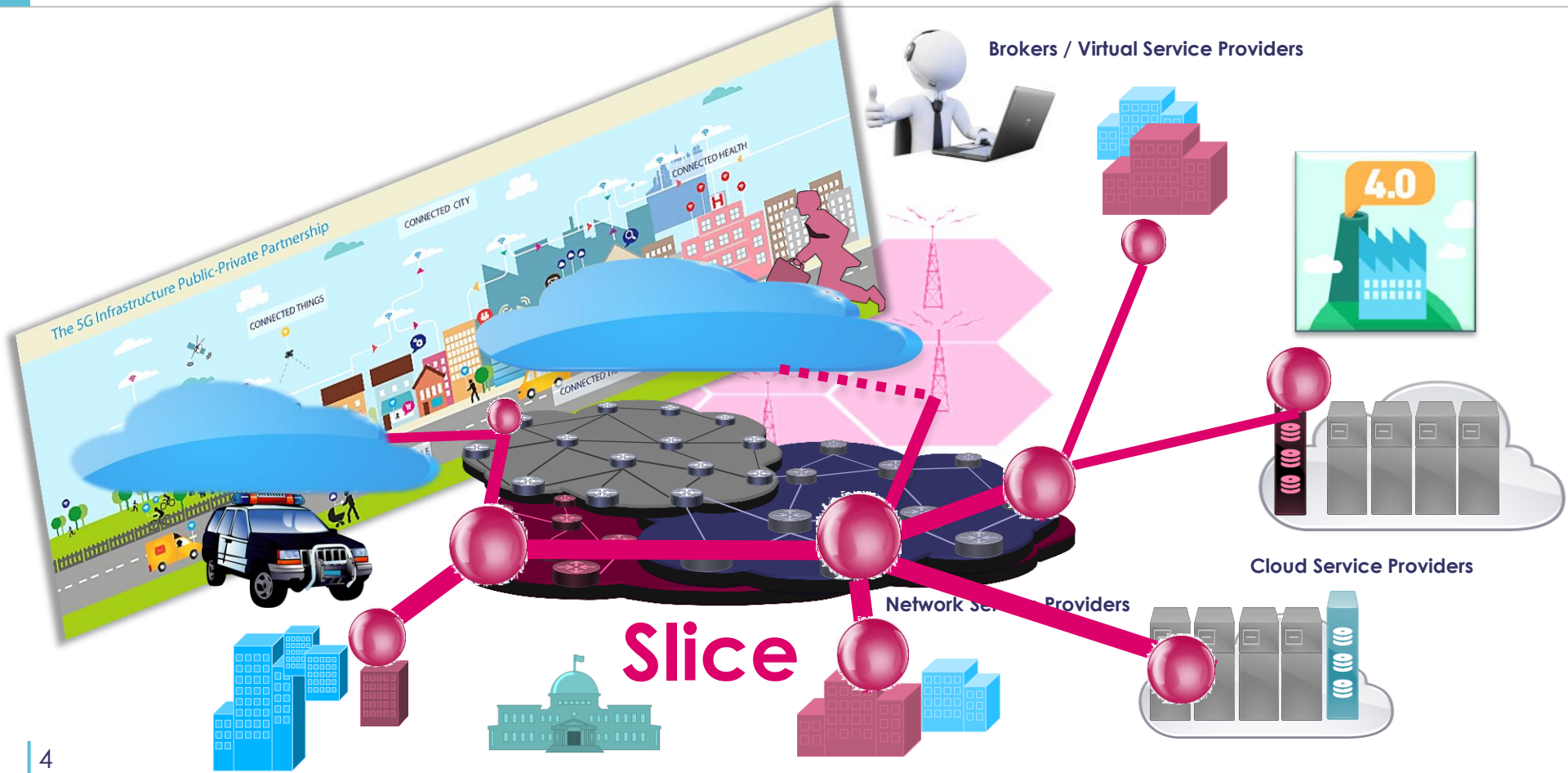
- But Inspired by 5GPPP, 5GMF, 5GForum, 4G americas, ETSI, 3G, IETF, OPNFV, ONF, Opendaylight, NGMN, Openstack,...and some others....
- ...leading to a very first set of observation:
  - that's a lot of people...
  - Stakeholders are different
    - Is it IT or GAFA or OTT against Service Providers ?
  - market is evolving
- Is there a rough consensus ?
  - Is interoperability still an objective ?

**Seeds for better resilience ?**

# About 5G scope



# New architecture, new roles, new issues,...



# Beyond the buzz: Maybe more reasons to (re-)think about resilience

## Architecture & Actors: new Scope & Mix

### ➤ ICT convergence

- More complex composition of sub-systems/services with respective security levels/policies etc...
- Mutualization, less infrastructure ownership, more service usages (XaaS)

### ➤ Multi-segment (often multi-party) horizontal End-to-End integration

- IoT newcomers, NSP, IT,...more segments/fragments
- Mobile Edge Computing (although a way to reach 1ms objective)
- Same End-to-End principle ? And thus reliability from unreliable parts ?

### ➤ Verticals including mission critical: ICT + OT convergence

- Smart cities, transport, industry...resilience, security (and safety) requirements increase, is it still “neutral” ?

# Beyond the buzz: Maybe more reasons to (re-)think about resilience

## ➤ Multi-layer vertical integration plus Multi-tenant “slices”

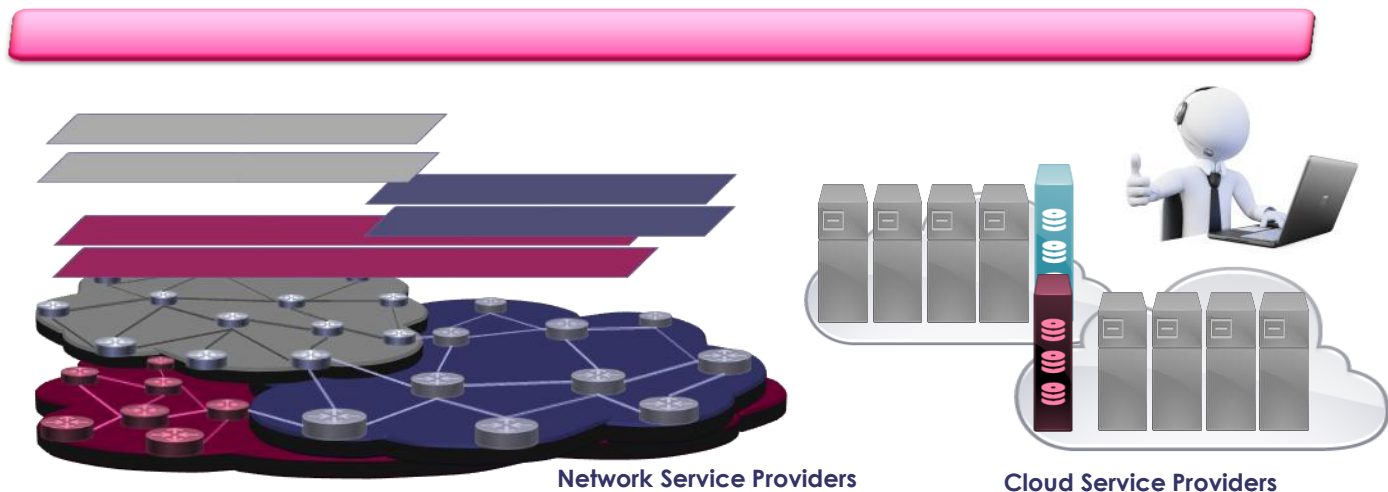
- Virtual operators and brokers
- Yet another instance of blind overlays and multi-layer or equivalent issues
  - Yes you may change the topology, and it's new control power !

## ➤ Slice

- Analytics
- policies

## ➤ Analytics layer

## ➤ Policy layer



# 5G: selected resilience-related comments about technologies

## ■ Main Technology evolutions

### ➤ Softwarization

- Really ?
- Actually more interfaces/APIs (although risks), different distribution and life cycle
- Stateful vs. stateless, CP/DP interactions, controllers failover,...

### ➤ Virtualization

- Any difference ? At least in terms of security

### ➤ Multi-RAT

- In parallel, flow/bearer matching/arbitration policy?
- Mobility management: vertical handover/roaming multi-provider ?

### ➤ Wireless backhauling

- Recovery resources, sensitivity to shared risk ?

# 5G: selected resilience-related comments about technologies

- Autonomic/Plug'n Play smart control
  - Analytics
  - Multi criteria optimization under resilience constraints
  - ...but who's doing what ?
- Service management
  - Priority, precedence
  - Life cycle
- Traffic encrypted
  - Not specific to 5G



## As an intermediate conclusion

### ■ 5G systems should be different in nature

- Summarized as metamorphic

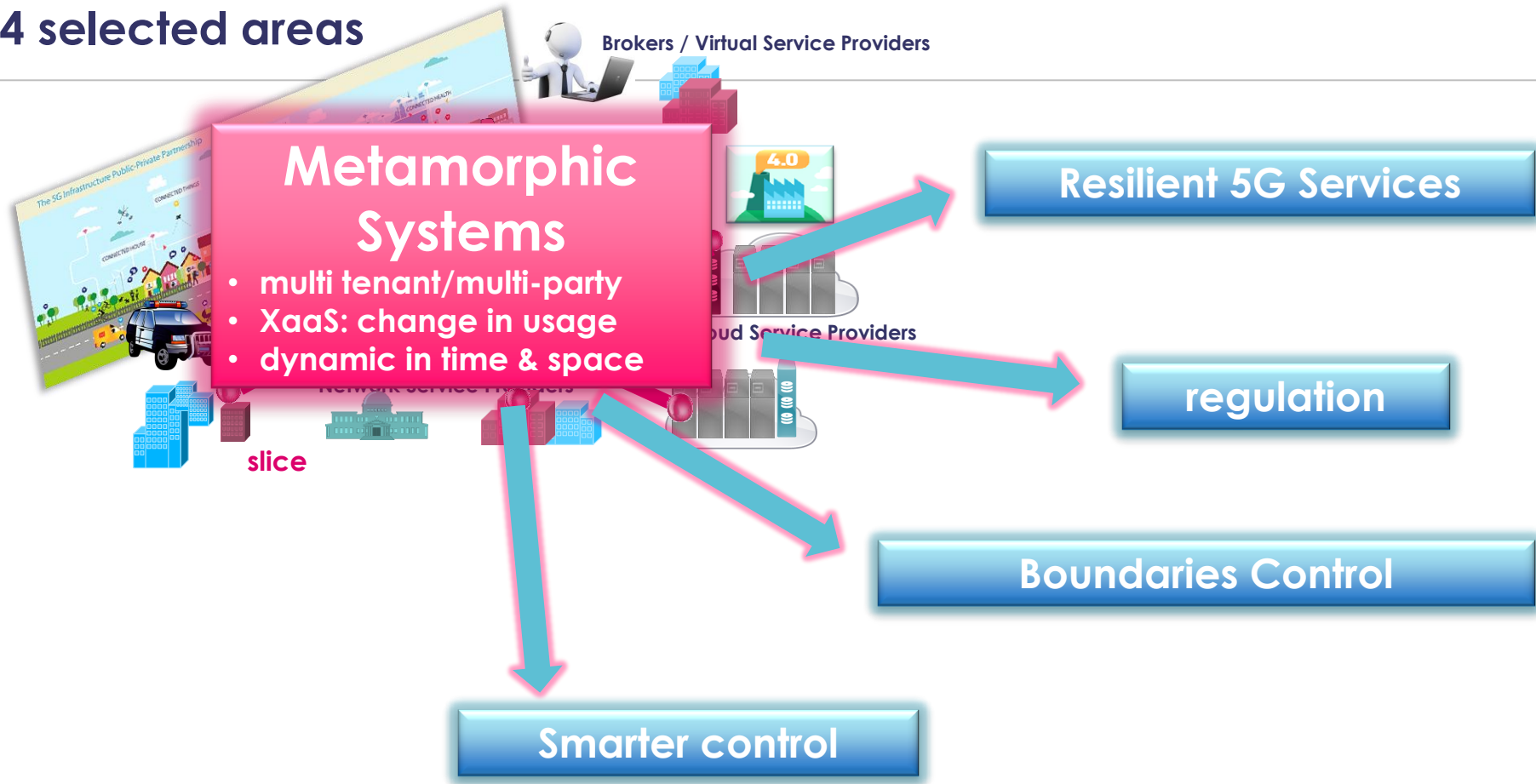
### ■ 5G services should encompass mission critical requirements

- Including infrastructure for verticals

### ■ 5G stakeholders role distribution is expected to face major changes

- Tenants (w/ slices), virtual operators, brokers, OTT, providers (IoT, MEC, Networks, clouds)

# 4 selected areas



Where is the menu ?



# 5G Resilient Services: related issues

## Discovery

- Similar to PCC-PCE requirements but...
- ... authority perimeter may vary
- ... security (authentication at least) must be in the loop

## Exposure

- Providers or virtual providers should be able to expose in some way their service catalog
- Updates and refresh as per resource evolution is an adjacent issue

## Template

- Clearly a gap in the 5G picture, there is no standard way to describe services as well as their resilience properties/attributes

# 5G Resilient Services: related issues

## Request/APIs/Negotiation

- Tenants/applications should be able to request and negotiate (such as tolerance margins) resilient 5G services. This is where the nICT convergence should apply, using same tools, APIs, protocols.
- Concurrence among applications/tenants requests should be arbitrated under some policies (including priorities and precedence for service continuity and/or critical services)

## Composition/market place

- How to compose the relevant end-to-end service, including entire slice, on top of multi-party offer (hundreds of potential providers)
- From multi-criteria computation to game theory application

## Assurance and verification

- SLA means ways to assure and verify actual delivery !

## Keep control



## ■ Do we have equivalent control compared to « old style » networking

### ➤ What do we keep from

- Monitoring,P&R mechanisms, Restart mechanisms
- Hold-of timers (wrt to the the increased number of layers/dependencies)
- ...

## ■ Performances of failover mechanisms ?

- ### ➤ Depending on number of distributed controllers, controllers and NFV placement, heartbeat (or not), overhead optimization,...

## ■ Being smart ?

### ➤ Going Software Defined Resilience

- Fine grain service resilience with minimal service disruption

**SLICE**

*THE FINAL FRONTIER..*





## ■ New Boundaries issues

- Strategy: OTT tenant (self) resilience
- What about underlayer disjointness, shared risk knowledge
- Control: event knowledge or detection as per service usage and openness
- Dynamic assesment of resources/services states
- Root cause analysis ?
- Liabilities
- Forensic
- Xdomain data exchanges in confidentiality
  - Multi-party computing application
- Blockchain usage for distributed trust and traces of operations
- ...

## Who's to blame/regulation



## Regulation & Standards...

- **Multi-actors liabilities is a risk for emerging concepts adoption...**
  - Distribution considering vertical/horizontal dependencies
- **Tracability and forensic issues applied to multi-tenant/party virtualized context**
- **Issues of evaluation and certification**
- **No standards for resilience attributes of services**

- **Change in system nature and multi-tenant/multi-party architecture generates de facto renewed questions on resilience approaches**
- **Resilience compliance and application in a XaaS world mandates tools, workflows, standards in the service plane**
- **Distribution of control specific to SDN and 5G picture not yet mature but coming with entire field of optimization and smart solutions**
- **Slice paradigm giving power to the tenants but also re-introducing known multi-layer issues to be addressed or falling into same old dependencies**
- **Clarity of liabilities (tenants vs. virtual operators vs. brokers vs. actual providers) may require some regulation....**

Thanks

