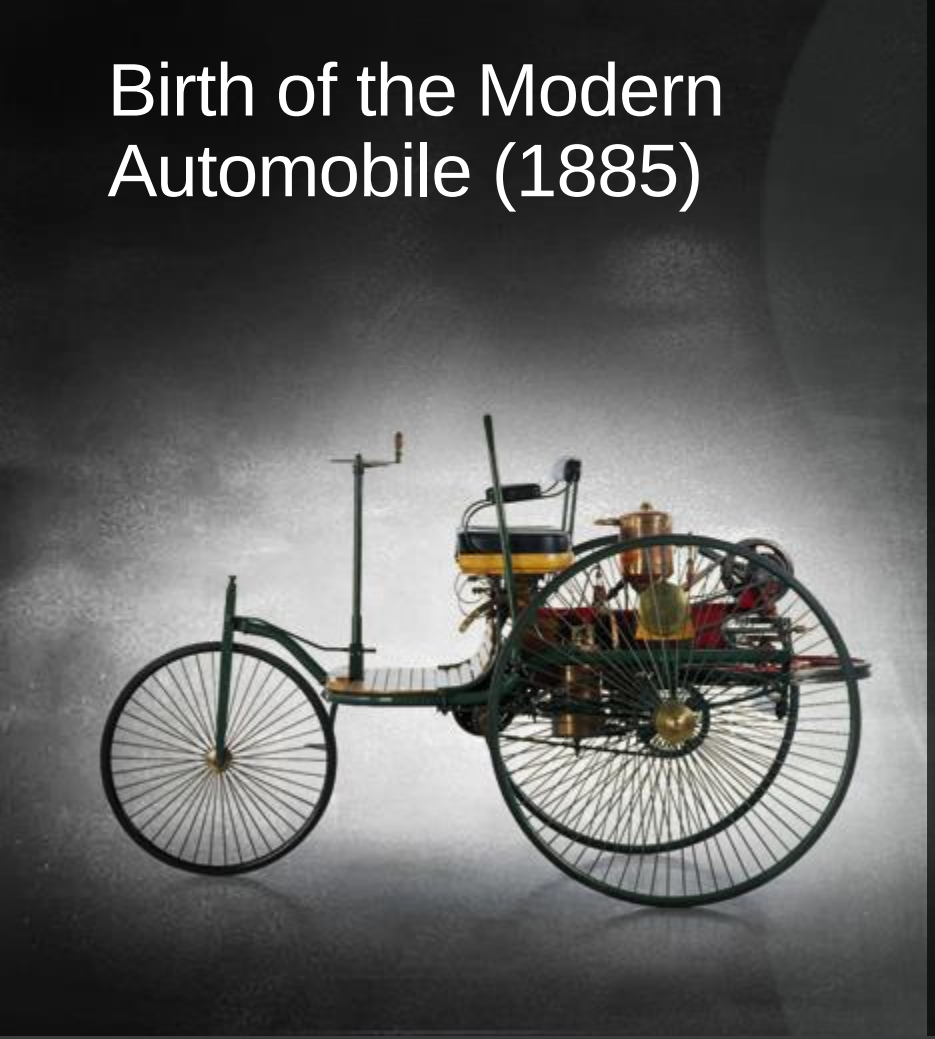
The Self-Driving *Edge* Network™

Kireeti Kompella SVP & CTO Engineering

Let’s Talk About Cars!

Birth of the Modern Automobile (1885)

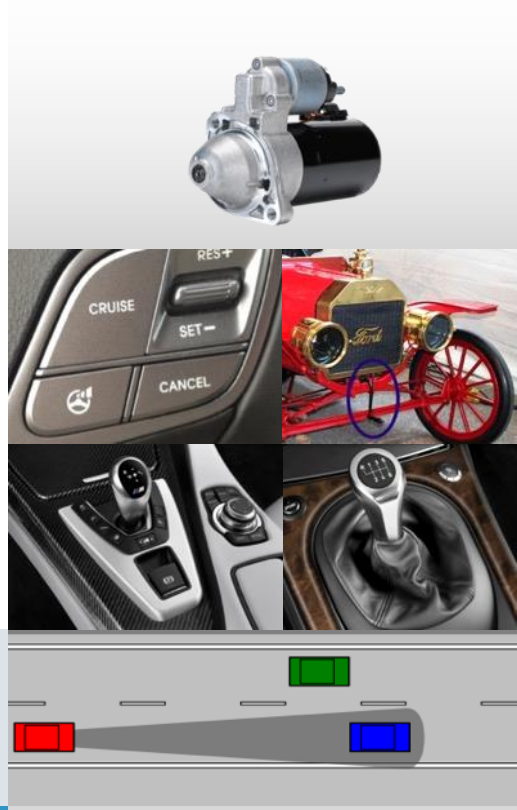


- **Benz Patent-Motorwagen**
  This was patented in 1886 (depicted here is v2)
- The car had a 954cc single-cylinder, four-stroke 0.9hp engine with **trembler coil** ignition and **evaporative carburetor** with **sleeve valve** to regulate speed and a manual **leather shoe** brake
- Very, very manual!
- **The Bertha Benz Memorial Route:** 194km from Mannheim via Heidelberg to Pforzheim

© 2016 Juniper Networks, Inc. All rights reserved.

Automation for the Automobile

Manual starting with a crank	→ electronic starter (1914)
Manual transmission	→ automatic transmission (1940)
Manual control of engine	→ cruise control (1948)
	→ adaptive CC (1997)
	→ intelligent ACC (2015)
Manual braking	→ antilock brake system (1971)
Manual steering	→ power steering → active steering
Manual parking	→ autonomous parking



- These are all excellent innovations that make driving easier
- The primary goal is mainly **convenience** and **safety**

Is that basically it?
Are we done with innovation in cars?

© 2016 Juniper Networks, Inc. All rights reserved.

The DARPA **Grand Challenge**

BUILD A FULLY AUTONOMOUS GROUND VEHICLE

GOAL

- Drive a pre-defined 240km course in the Mojave Desert along freeway I-15

PRIZE

- $1 Million

RESULT

- **2004:** **Fail** (best was less than 12km!)
- **2005:** 5/23 completed it

2007: “URBAN CHALLENGE”

- Drive a 96km urban course following traffic regulations & dealing with other cars
- 6 cars completed this

IMPACT:

- **Programmers, not drivers**
- No cops, lawyers, witnesses
- Quadruple highway capacity
- Glitches, insurance?
- Ethical Self-Driving Cars?

POSSIBILITIES (2)

© 2016 Juniper Networks, Inc. All rights reserved.

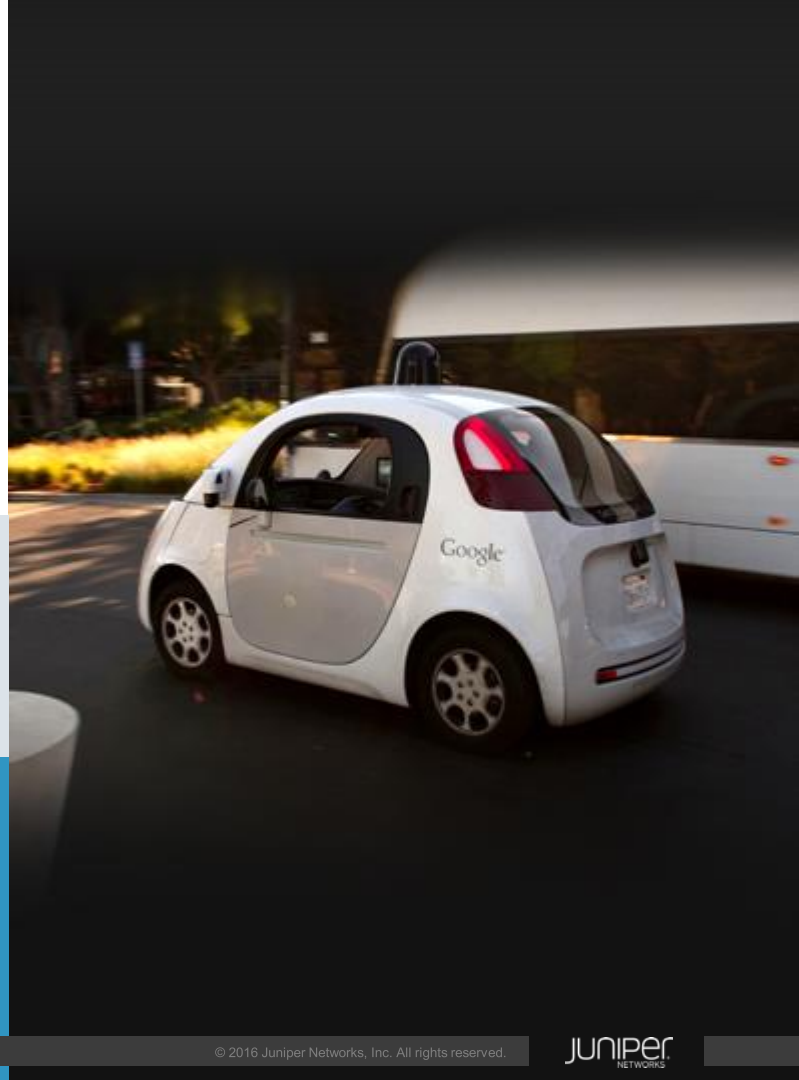
The Self-Driving Car: **Grand Result** (2009, 2014)

- No steering wheel, no pedals—a completely autonomous car
- Not just an incremental improvement

This is a **DISRUPTIVE** change in automotive technology!

Auto Correct—*New Yorker* (2014)

The Massive Economic Benefits of Self-Driving Cars—*Forbes*



© 2016 Juniper Networks, Inc. All rights reserved.

THE NETWORKING **GRAND CHALLENGE**

BUILD A SELF-DRIVING NETWORK

GOAL

- Self-Discover—Self-Configure—Self-Monitor—Self-Correct—Auto-Detect Customers—Auto-Provision—Self-Diagnose—Self-Optimize—Self-Report

RESULT

- Free up people to work at a higher-level: new service design and “mash-ups”
- Agile, even anticipatory service creation
- Fast, intelligent response to security breaches

CHALLENGE

- Build and operate a self-driving edge network that greatly increases service agility and vastly improves service quality by proactive maintenance
- Autonomously run the end-to-end life-cycle of a service
- Learn user behavior and anticipate changing user requirements

IMPACT:

- **New skill sets required**
- **New focus**
  - BGP/IGP policies → AI policy
  - Service config → service design
  - Reactive → proactive
  - Firewall rules → anomaly detection

POSSIBILITIES

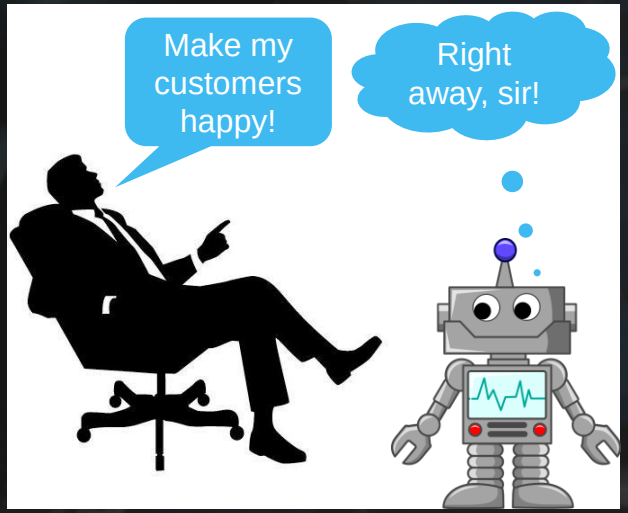
© 2017 Juniper Networks, Inc. All rights reserved.

FIVE TECHNOLOGIES FOR SELF DRIVING

1. **DECLARATIVE INTENT**
2. **TELEMETRY**
3. **CORRELATION**
4. **AUTOMATION**
5. **DECISION MAKING**
   - A. RULE-BASED
   - B. MACHINE LEARNING

© 2017 Juniper Networks, Inc. All rights reserved.

1. INTENT: “Say *What* You Want, Not *How* to Do It”



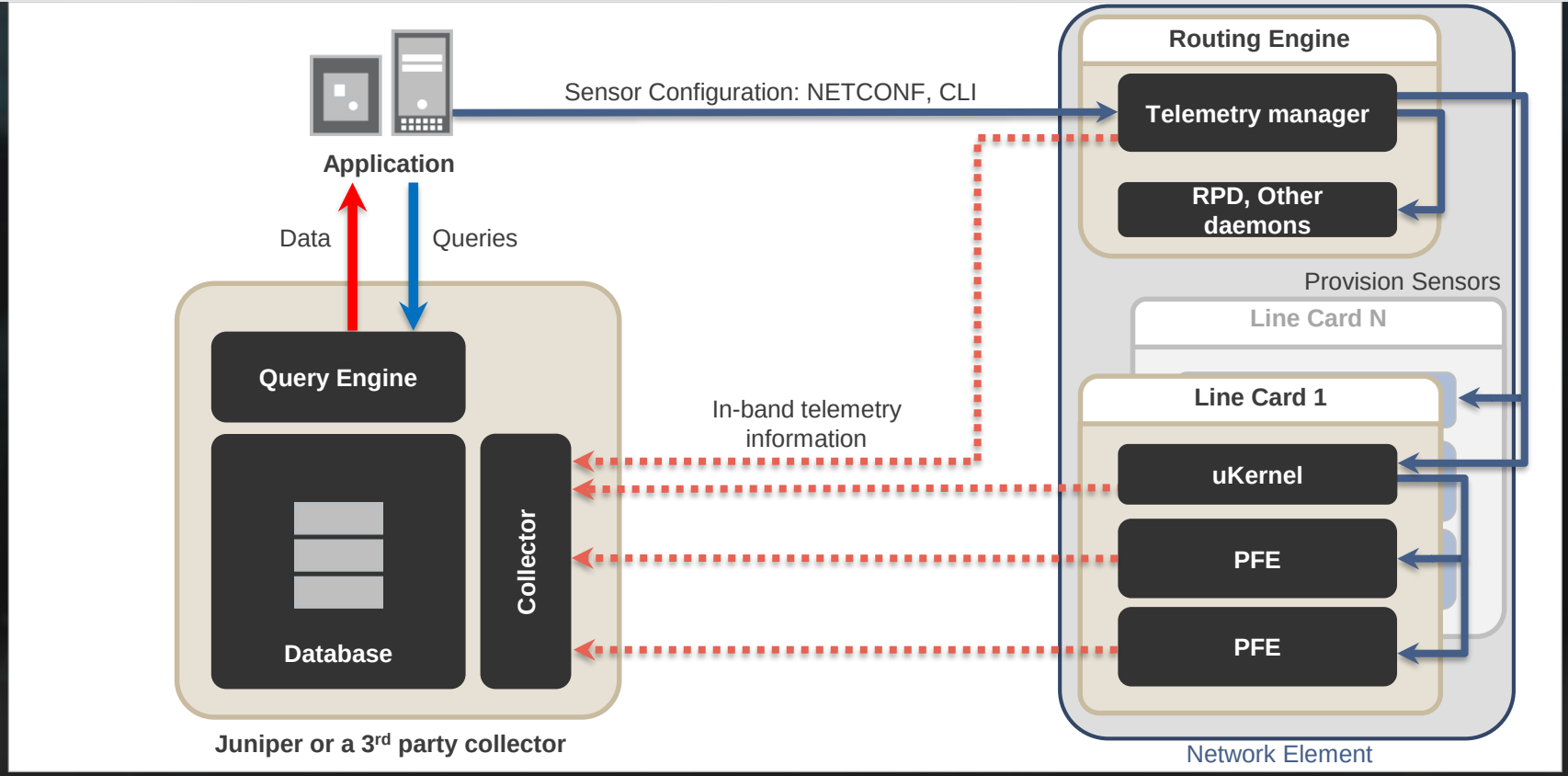
Juniper products with *Intent*:

Contrail: specify your intent regarding Virtual Networks interactions. A new or moved VM automatically gets the right policies and rules

NorthStar: specify your WAN connectivity requirements – bandwidth, resilience, QoS. These are automatically implemented.

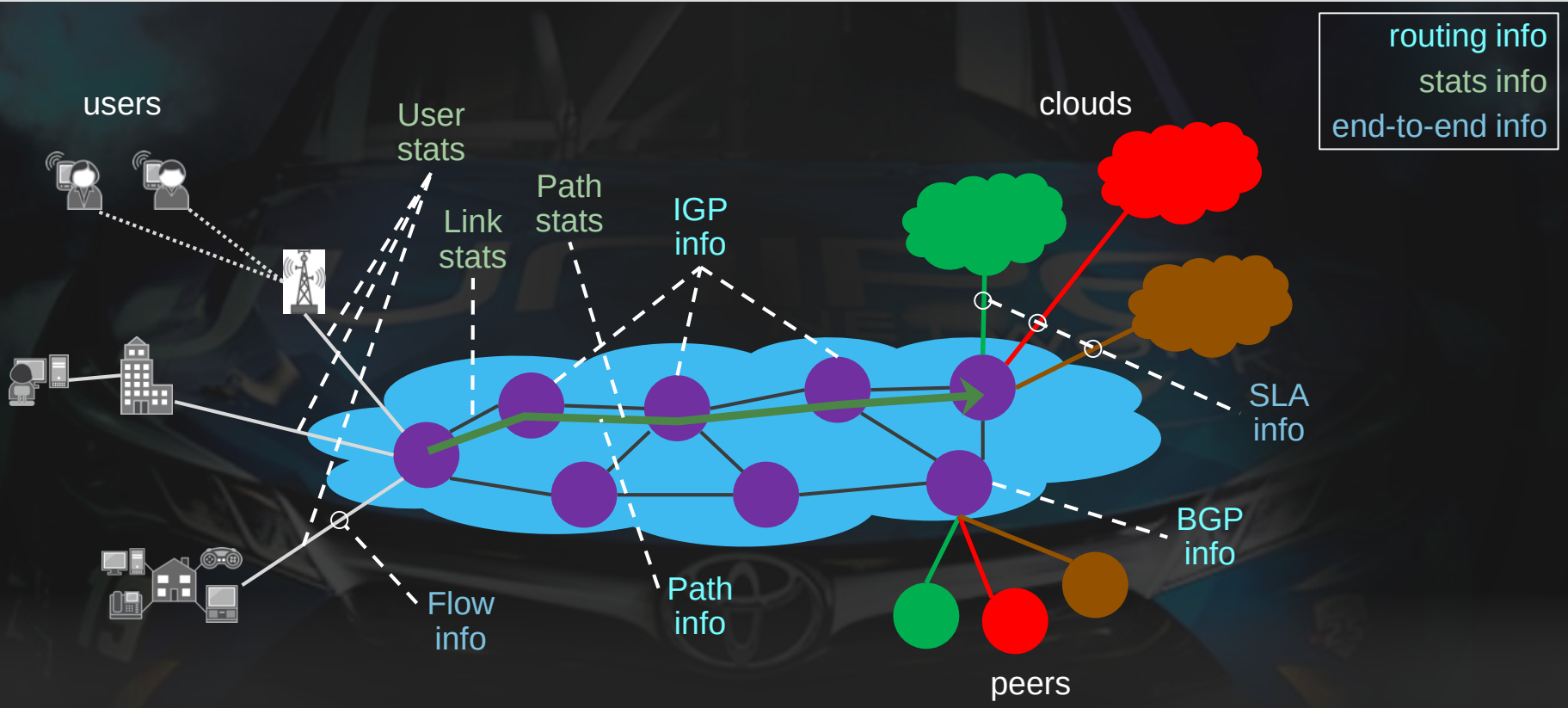
© 2017 Juniper Networks, Inc. All rights reserved.

2. TELEMETRY—“networking big data”



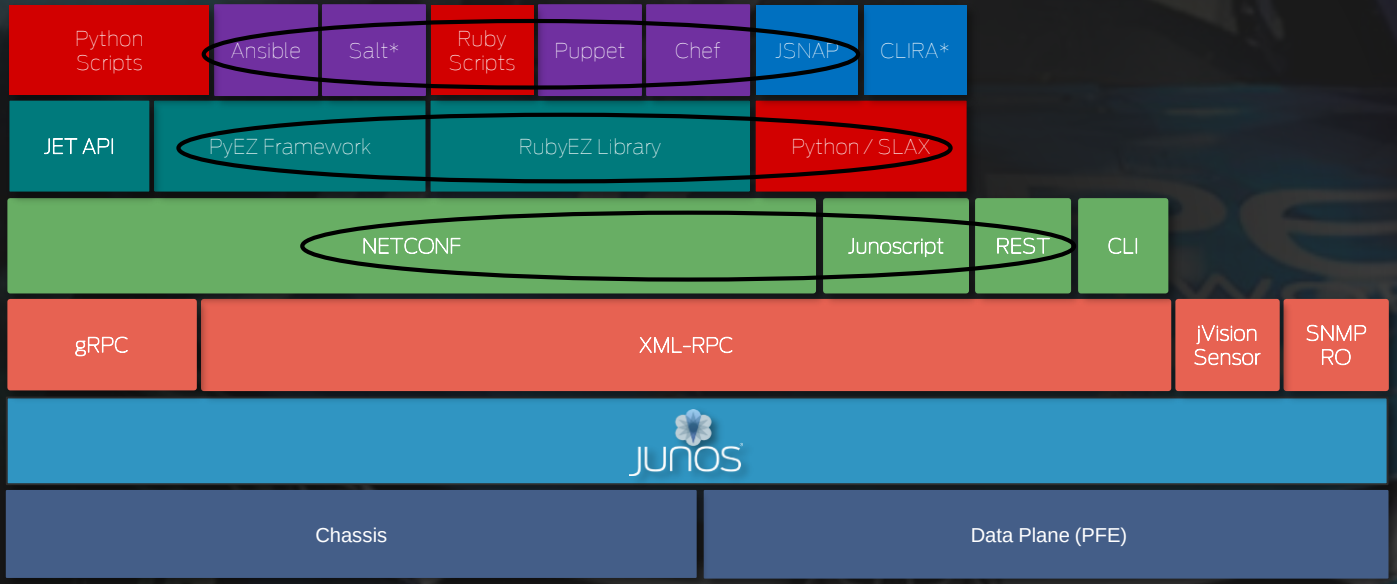
© 2017 Juniper Networks, Inc. All rights reserved.

3. CORRELATION—“networking analytics”



© 2017 Juniper Networks, Inc. All rights reserved.

4. NETWORKING AUTOMATION: generalize, replicate



Junos Platform Automation Stack

* In development

© 2017 Juniper Networks, Inc. All rights reserved.

5. DECISION MAKING—RULE-BASED VS. MACHINE LEARNING

RULE-BASED LEARNING

If X happens, do Y; avoid big rocks

- "if this then that" – IFTT

+Straightforward programming

+Easy to predict and refine

- Slow, painstaking work
- Complexity with scale

MACHINE LEARNING

"Essence of artificial intelligence"
—Alan Turing

+Can become "creative"

+Fastest way to learn complex behavior

- Can come to strange conclusions
- Hard to know what it knows, debug

© 2017 Juniper Networks, Inc. All rights reserved.

5. NETWORKING DECISION MAKING—what decisions?

SERVICE PLACEMENT: which device should offer a given service?

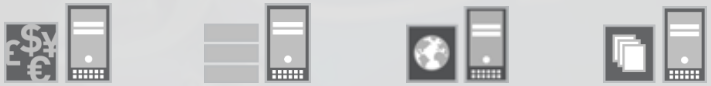
1. Specify Service Intent — Don't worry about where it will be
2. Where best to place the service? — Let the controller work this out
3. Things change: is placement still optimal? — Streaming real-time data
4. Service Motion: move service to a new location — Update service in real-time

Break the mold! Update service placement often, to keep it optimal

© 2017 Juniper Networks, Inc. All rights reserved.

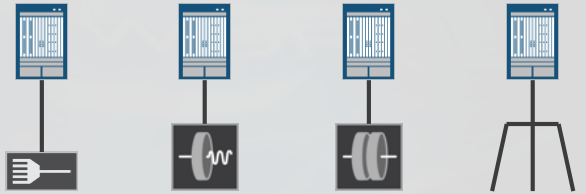
ANALOGY: Compute Orchestration vs Service Orchestration

OLD: Same (or very similar) servers running **dedicated** apps



Finance DB Web Apps

OLD: Same (or very similar) routers running **dedicated** services

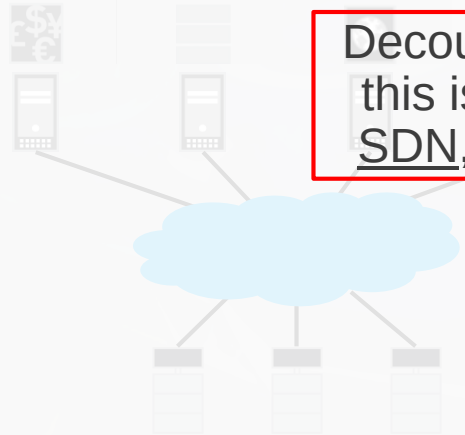


BNG CMTS BizPE Peering

© 2017 Juniper Networks, Inc. All rights reserved.

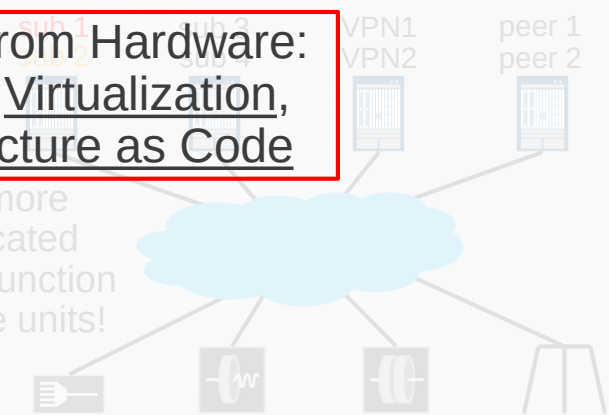
ANALOGY: Compute Orchestration vs Service Orchestration

NEW: Apps decoupled from servers;
storage available to all servers;
servers are now identical



No more
dedicated
single function
servers!

NEW: Services are decoupled from routers;
access devices available to all routers;
routers are now identical



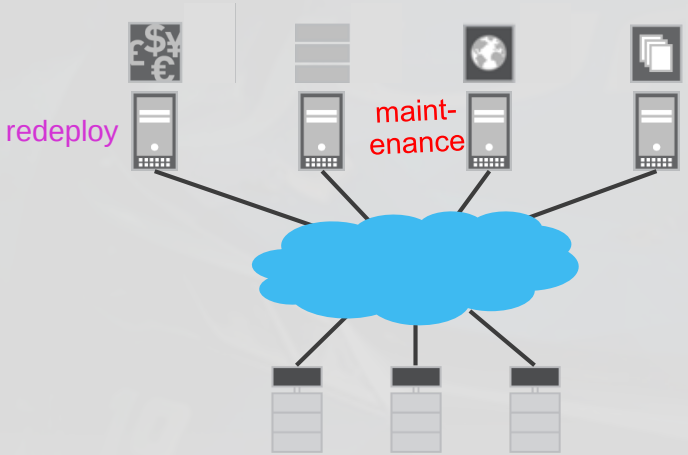
No more
dedicated
single function
service units!

Decoupling Apps/Services from Hardware:
this is the True Meaning of Virtualization,
SDN, NFV, Agility, Infrastructure as Code

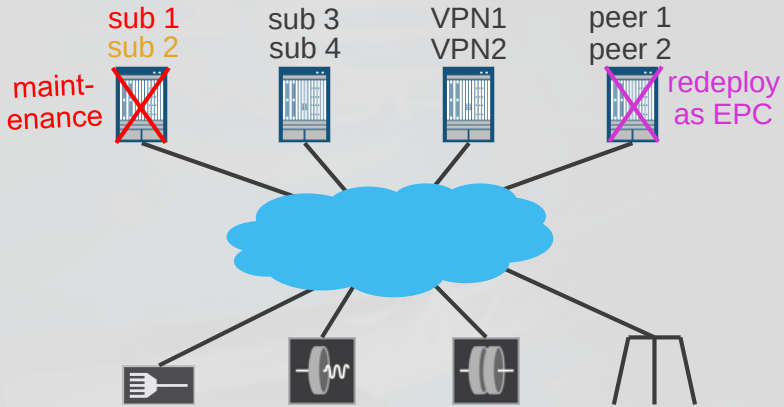
© 2017 Juniper Networks, Inc. All rights reserved.

ANALOGY: Compute Orchestration vs Service Orchestration

NOW POSSIBLE: “vMotion” of individual apps across servers; app placement is now a thing



NOW POSSIBLE: “sMotion” of individual services across routers; service placement is now a thing



© 2017 Juniper Networks, Inc. All rights reserved.

FIVE STAGES OF SELF DRIVING

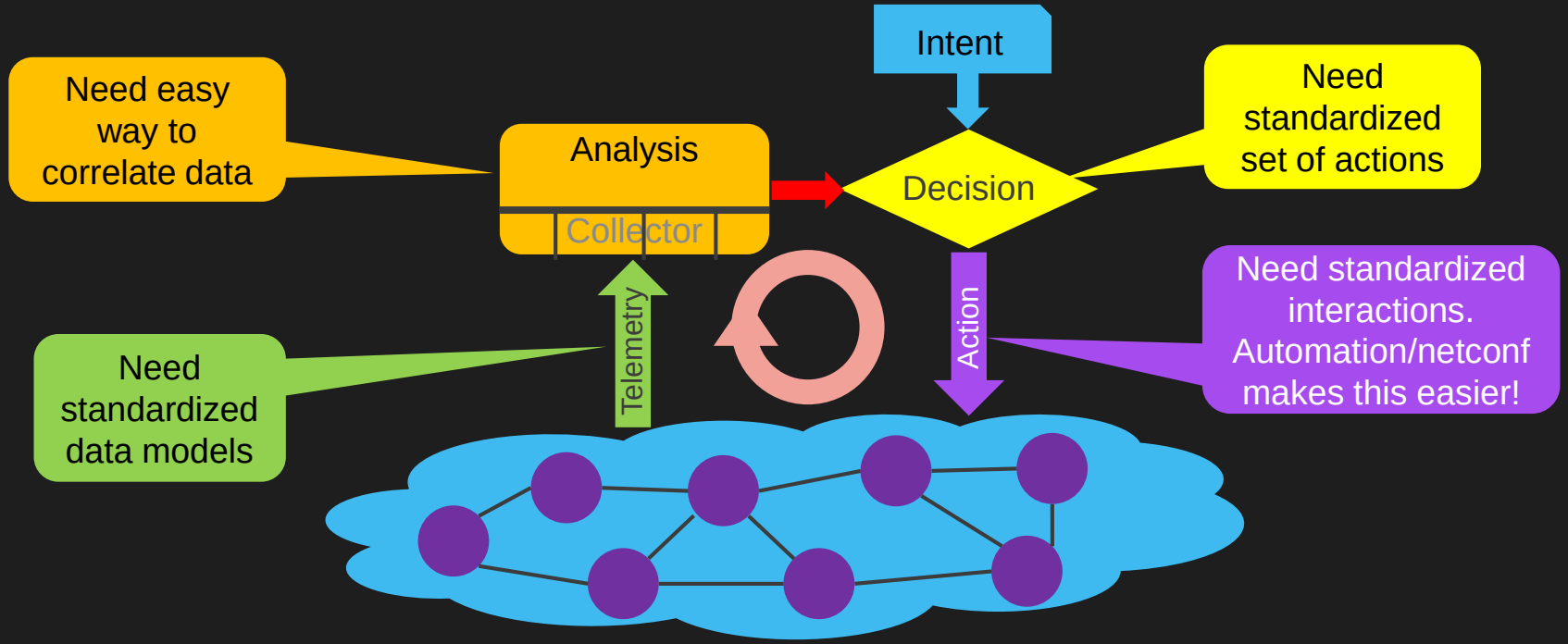
1. MANUAL
2. VISUALIZATION
3. PREDICTION
4. RECOMMENDATION
5. AUTONOMY

from here

to here!

© 2017 Juniper Networks, Inc. All rights reserved.

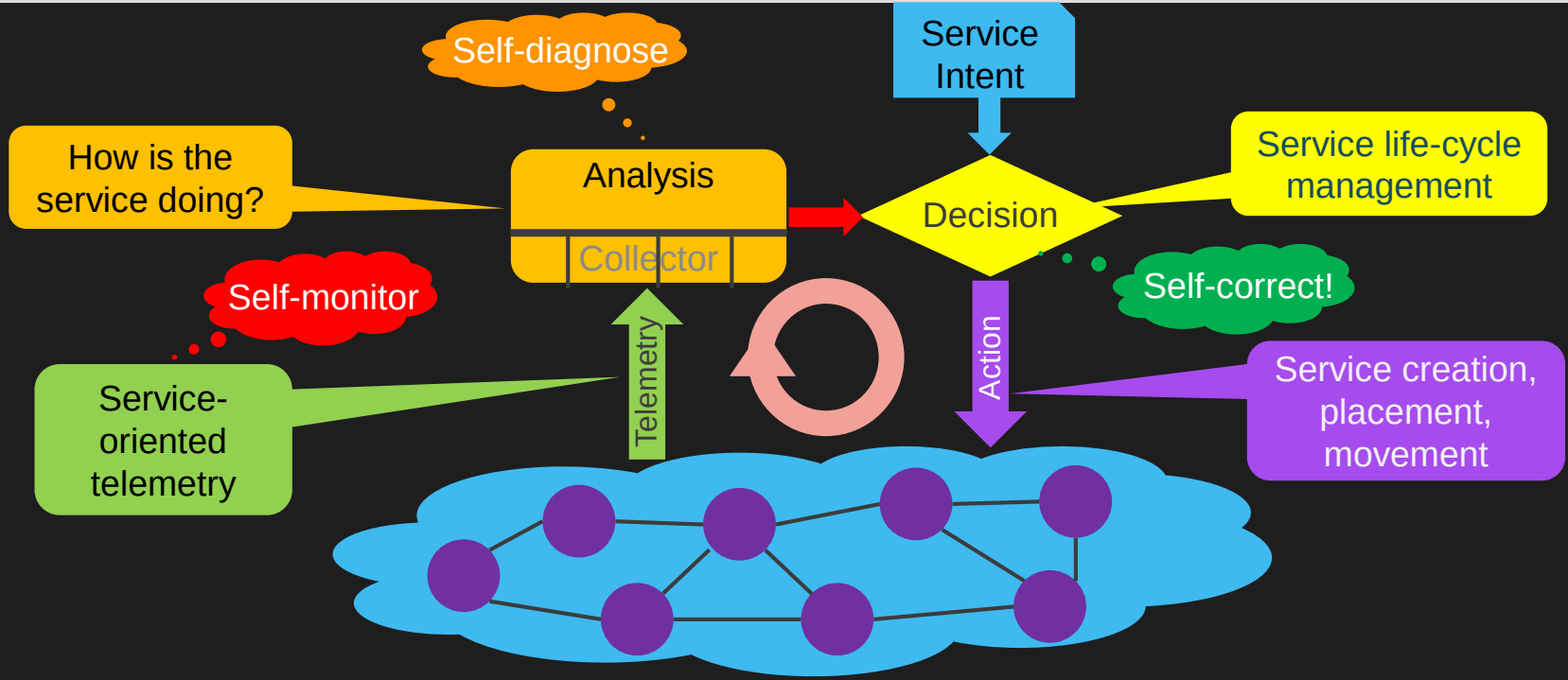
HIGH-LEVEL ARCHITECTURE: (nearly) Closed Loop Control



© 2017 Juniper Networks, Inc. All rights reserved.

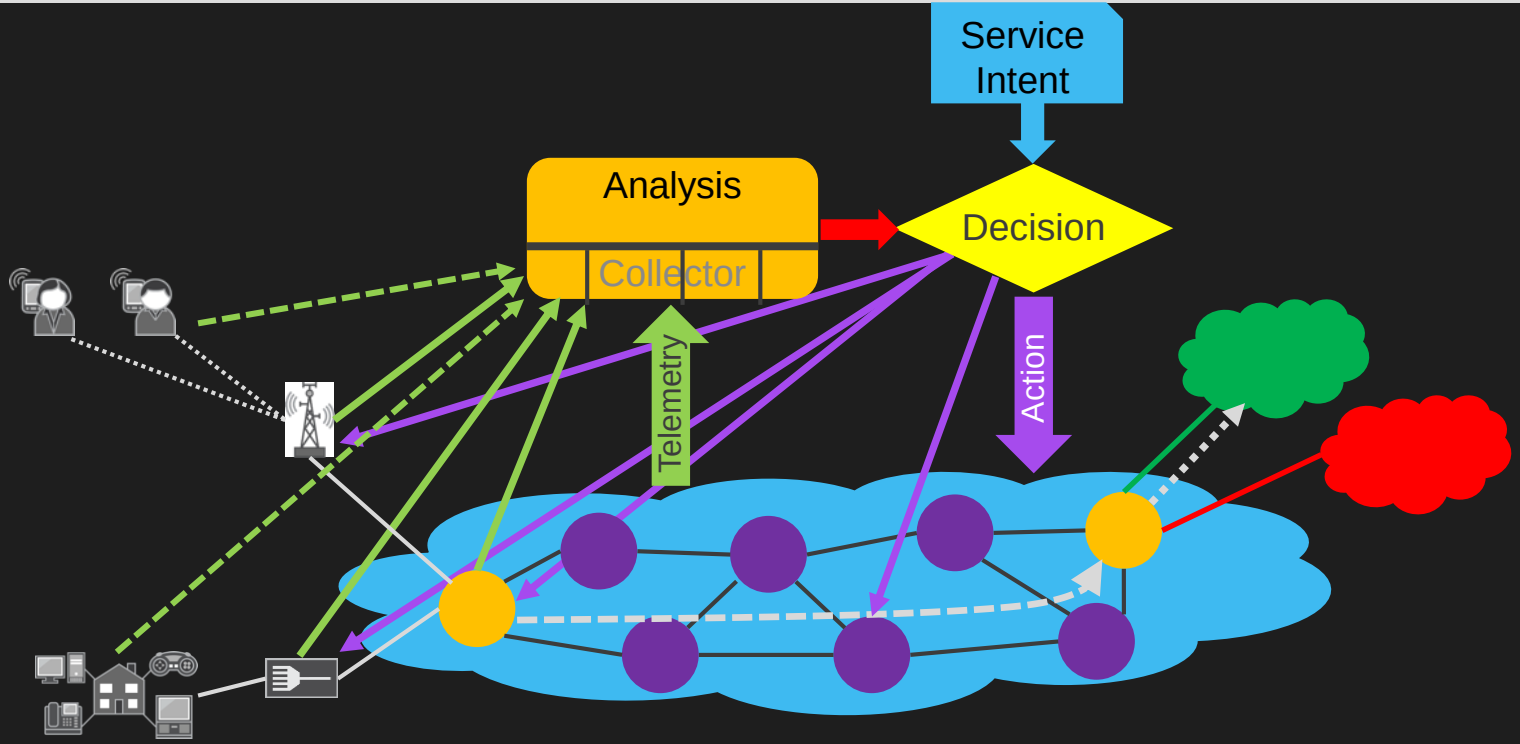
Self Driving EDGE Networks

Closed Loop Control of a Service Edge Network



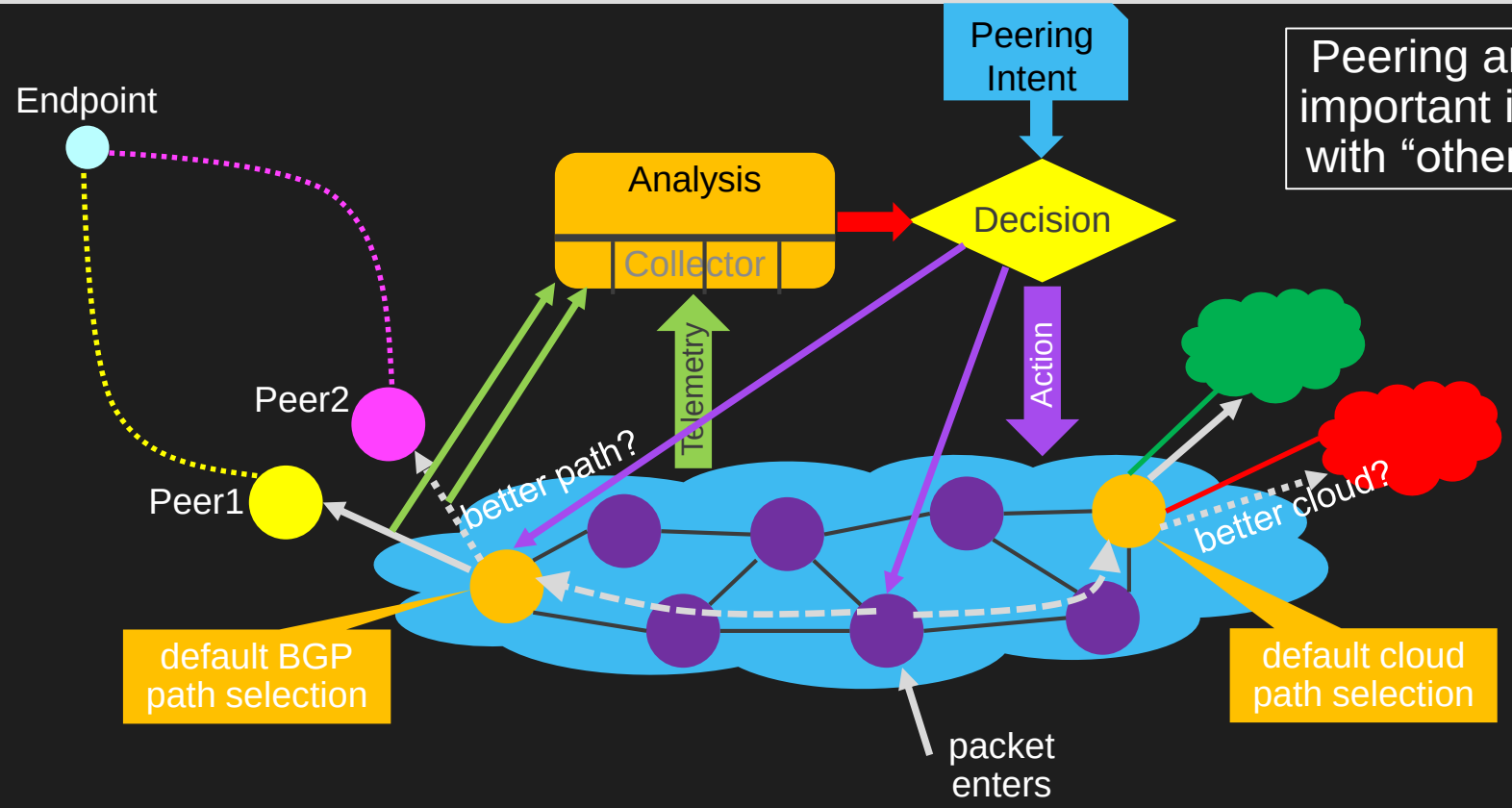
© 2017 Juniper Networks, Inc. All rights reserved.

APPLICATION: BNG/mobile services



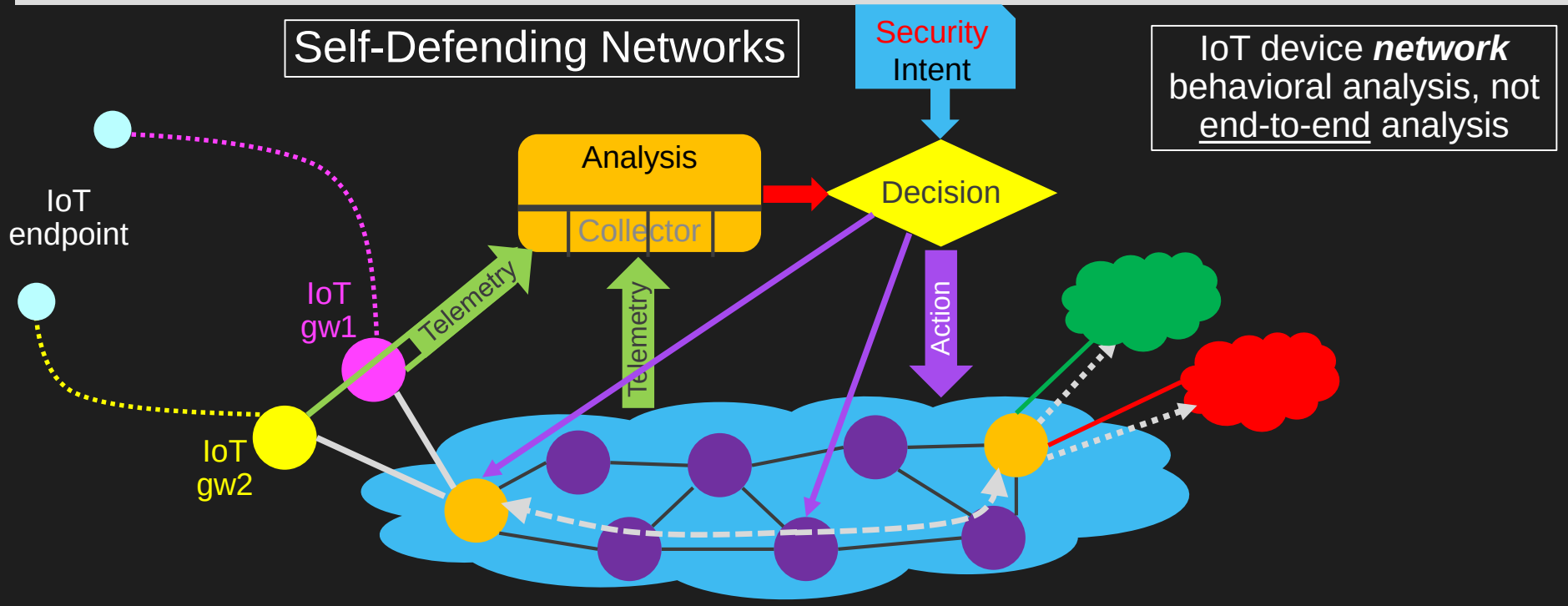
© 2017 Juniper Networks, Inc. All rights reserved.

APPLICATION: Intelligent Peering/Multi-Cloud



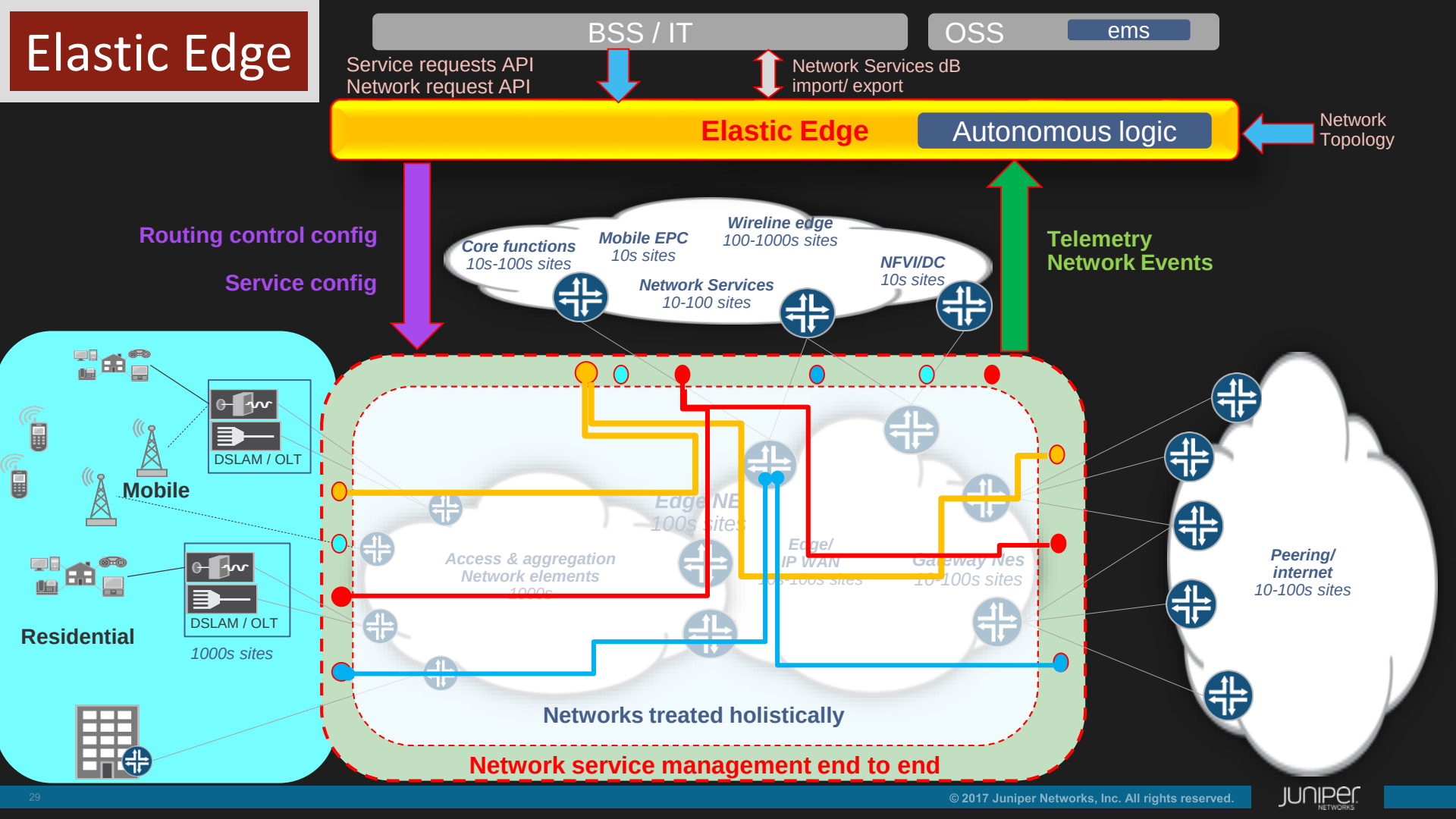
© 2017 Juniper Networks, Inc. All rights reserved.

APPLICATION: IoT Security via Network Behavioral Analysis



© 2017 Juniper Networks, Inc. All rights reserved.

Elastic Edge



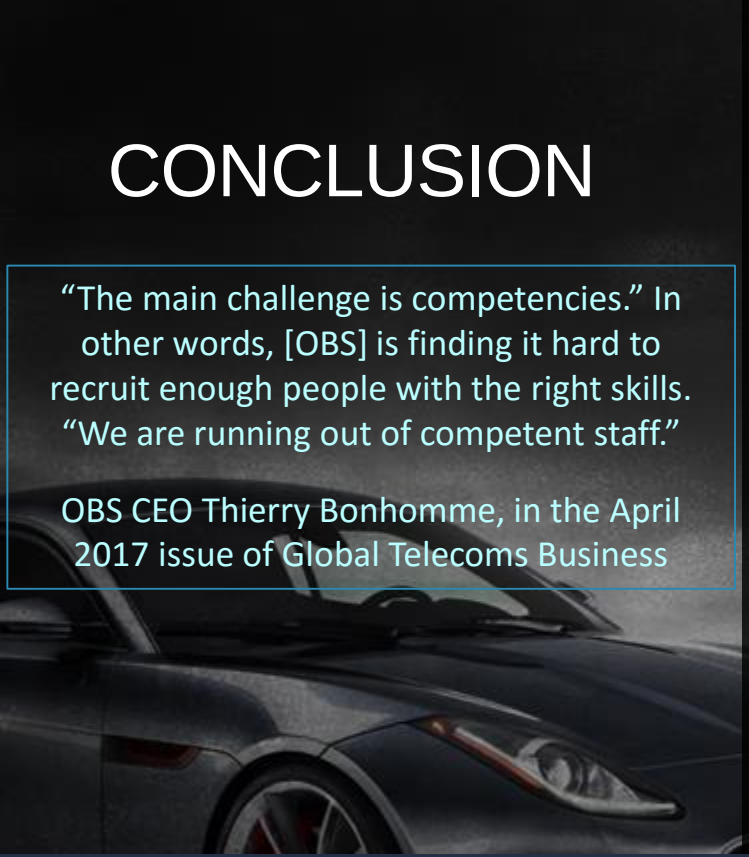
© 2017 Juniper Networks, Inc. All rights reserved.

FIVE BENEFITS OF THE SELF DRIVING SERVICE NETWORK WITH *ELASTIC EDGE*

1. **HIGH-LEVEL, INTENT-BASED SERVICE DESCRIPTION**
2. **END-TO-END, DEVICE INDEPENDENT SERVICE MGMT**
3. **OPTIMAL, TELEMETRY-BASED SERVICE PLACEMENT**
4. **REAL-TIME SERVICE OPTIMIZATION via SERVICE MOTION**
5. **AUTOMATIC MGMT OF UNDERLAY TO MATCH SERVICES**

© 2017 Juniper Networks, Inc. All rights reserved.

CONCLUSION



"The main challenge is competencies." In other words, [OBS] is finding it hard to recruit enough people with the right skills. "We are running out of competent staff."

OBS CEO Thierry Bonhomme, in the April 2017 issue of Global Telecoms Business

We need a compelling vision in networking, one really worth pursuing

- Current thought reflects the networking industry's fear of bold ideas
- The demand for service agility is unmet
- The need for proactive service mgmt is unmet
- There is an economic imperative for this
- There is a skill-set imperative for this
- There is a security imperative for this

Here is a vision worth pursuing: **The Self-Driving Network**

And the place to start: **The Network Service Edge**