



The Self-Driving Network

How to Realize It

Kireeti Kompella, CTO, Engineering

The Self-Driving Network

In March 2016, I presented the vision of a Self-Driving Network – an automated, fully autonomous network

I drew an analogy with the vision of a self-driving car

- **There, it took 10 years from vision to prototype**
- **The first attempt (in 2004) failed!**

What will it take to realize the Self-Driving Network?

The Self-Driving Car Journey

2004

DARPA Grand Challenge:
build a self-driving car



2014



The Self-Driving Network: What It Does



A self-driving network would

- Accept “guidance” from a network operator
- Self-discover its constituent parts
- Self-organize and self-configure
- Self-monitor using probes and other techniques
- Auto-detect and auto-enable new customers
- Automatically monitor and update service delivery
- Self-diagnose using machine learning and self-heal
- Self-report periodically

FIVE TECHNOLOGIES FOR SELF DRIVING

1. TELEMETRY

2. MULTIDIMENSIONAL VIEWS

3. AUTOMATION

4. DECLARATIVE INTENT

5. DECISION MAKING

A. RULE-BASED

B. MACHINE LEARNING

1. TELEMETRY—CARS

The usual: speedometer, gas gauge, tire pressure sensors

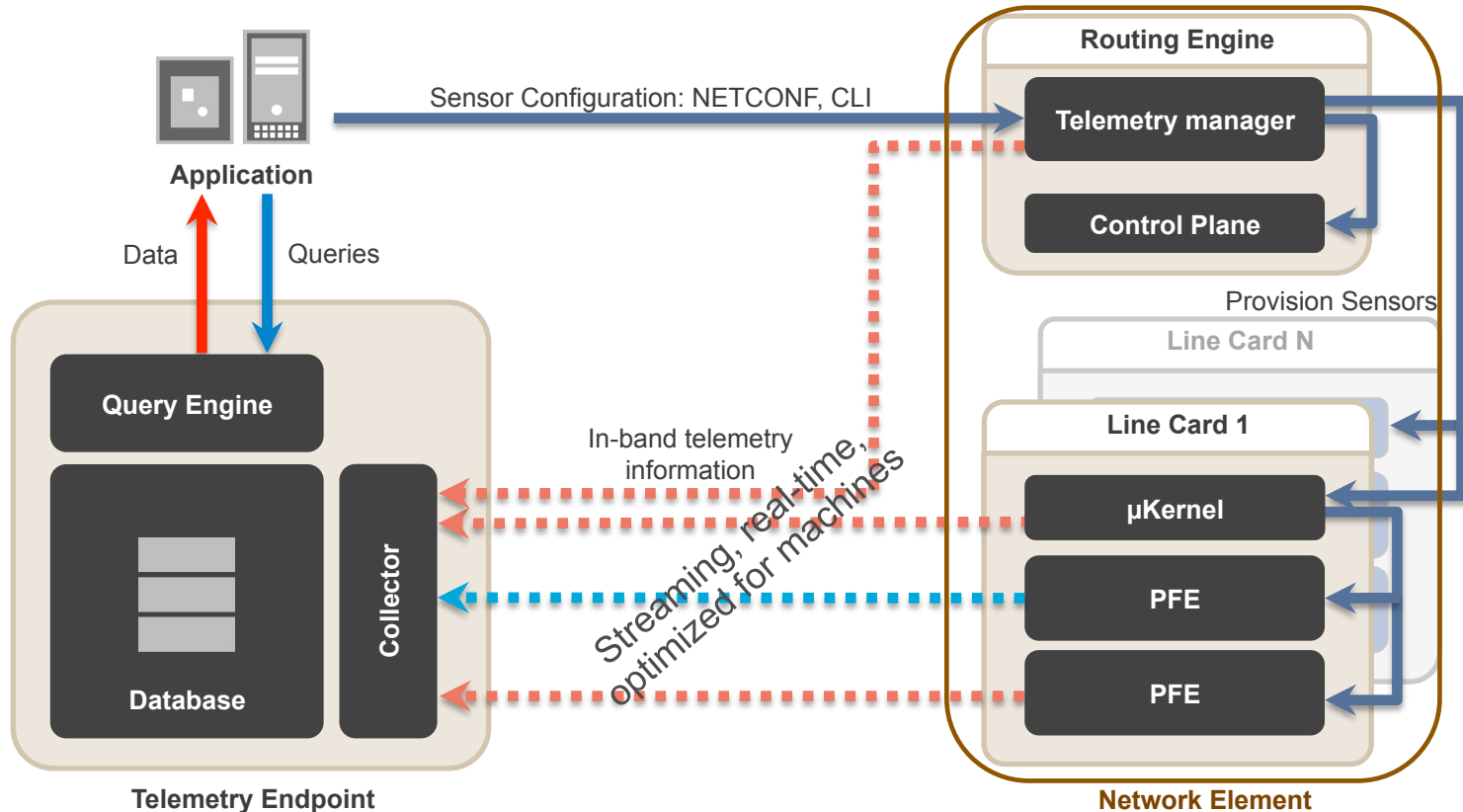
More recent: radar (for ACC), sonar (for parking assist), cameras

A laser sensor scans
360 degrees around the
vehicle for objects.



LiDAR

1. TELEMETRY—NETWORKS: where we are today



2. MULTIDIMENSIONAL, MULTI-MODAL VIEWS

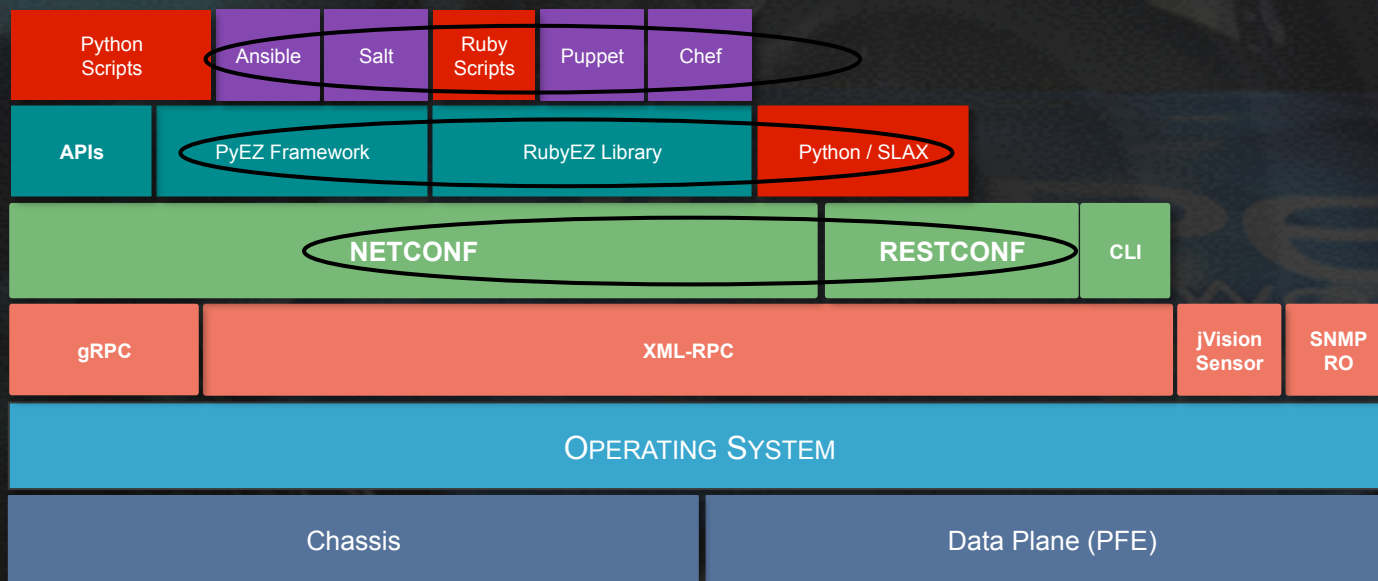
NETWORK TODAY

- Neighbors, links
- Exit points, peers
- L0-1 devices
- Middle-boxes
- Global topology, traffic, flows
- Server and application performance
- Hackers, flash crowds, DDoS

NETWORK (FUTURE)

- Correlation of information across geographies, layers, peers, clouds
- Root cause analysis via supervised learning
- Time-based trending to establish and adapt baselines
- Optimal local decisions based on global state

3. AUTOMATION—NETWORKS: where we are today



4. DECLARATIVE STATEMENT OF INTENT—CARS

SAY WHERE YOU WANT TO GO...

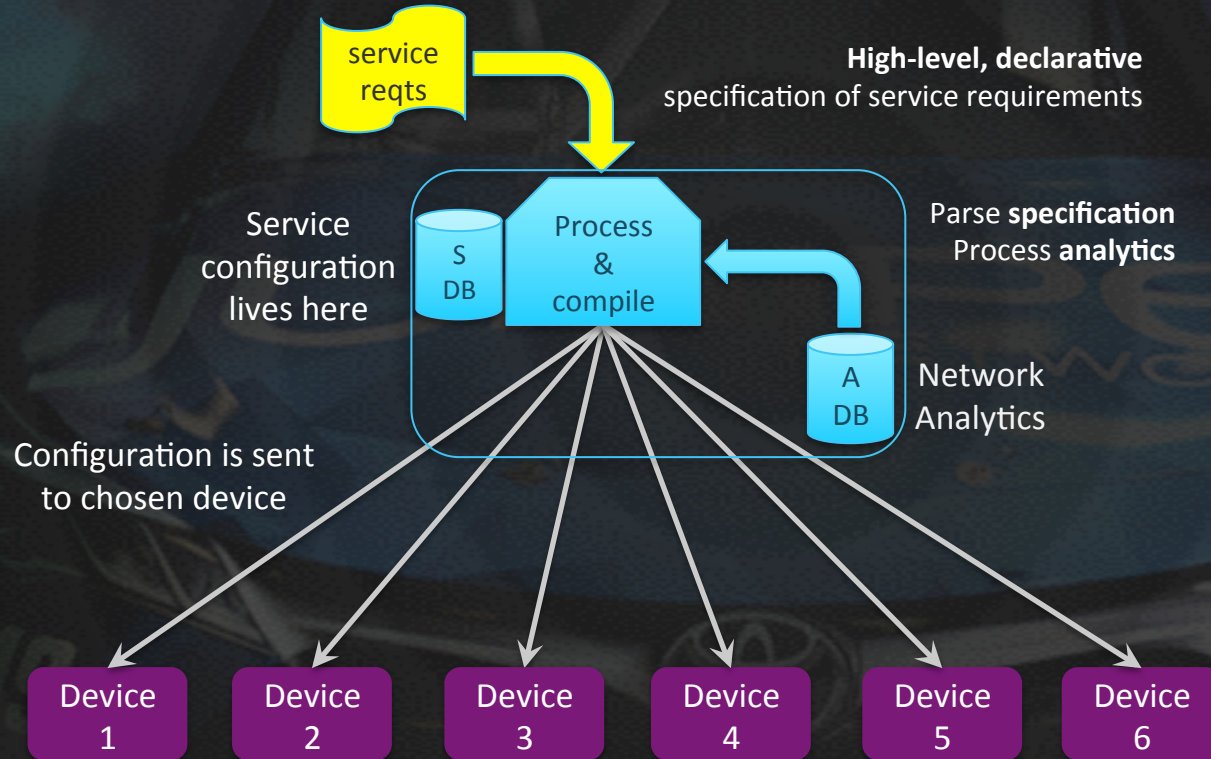
Hints:

- Fastest time
- Least distance
- Most efficient use of battery



Even better, the car can simply talk to your phone, figure out where you need to be, and take you there

4. INTENT: “Say *What You Want*, Not How” – where we are today



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

RULE-BASED LEARNING

If X happens, do Y: “avoid big rocks”
—“If this then that”

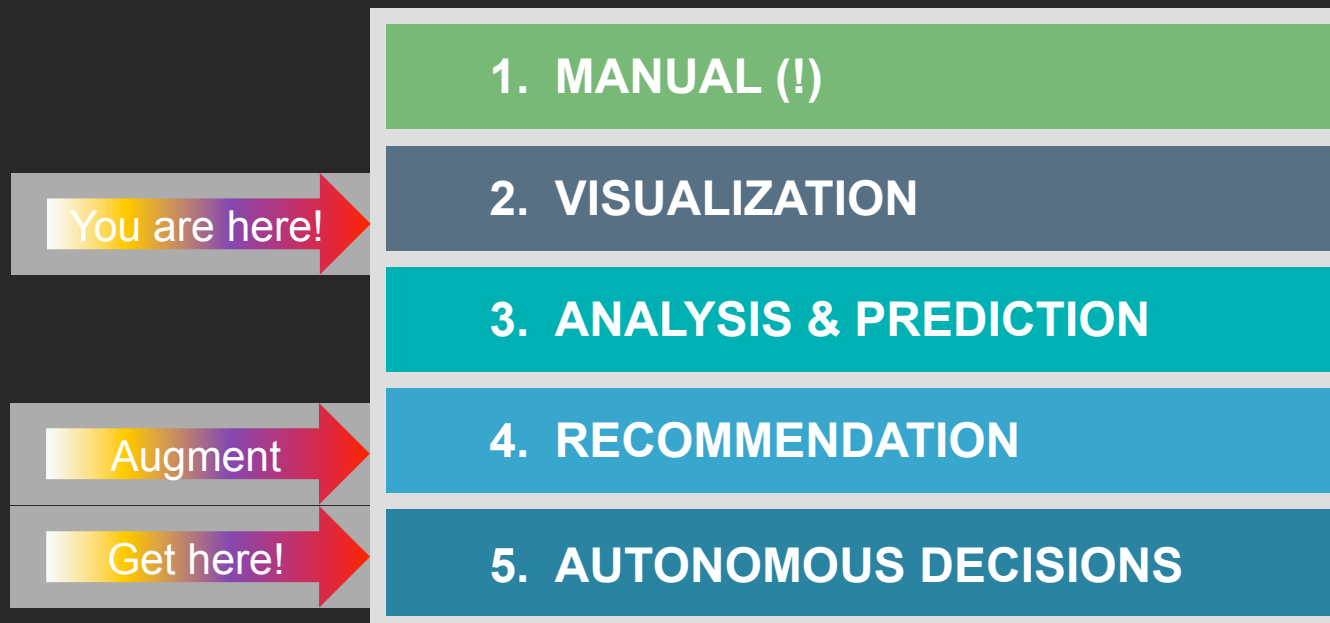
- +Straightforward programming
- +Easy to predict and refine
- Slow, painstaking work
- At scale, hard to manage

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

FIVE STAGES OF SELF-DRIVING





How Do We Get
This Kicked Off?

THE NETWORKING GRAND CHALLENGE

BUILD A SELF-DRIVING NETWORK

GOAL

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

PRIZE

- TBD

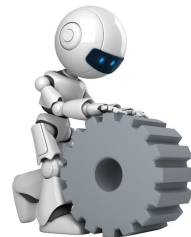
RESULT

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

CHALLENGE

- Run a datacenter for six months with no human intervention (not even from afar) with no reduction or compromise in functionality

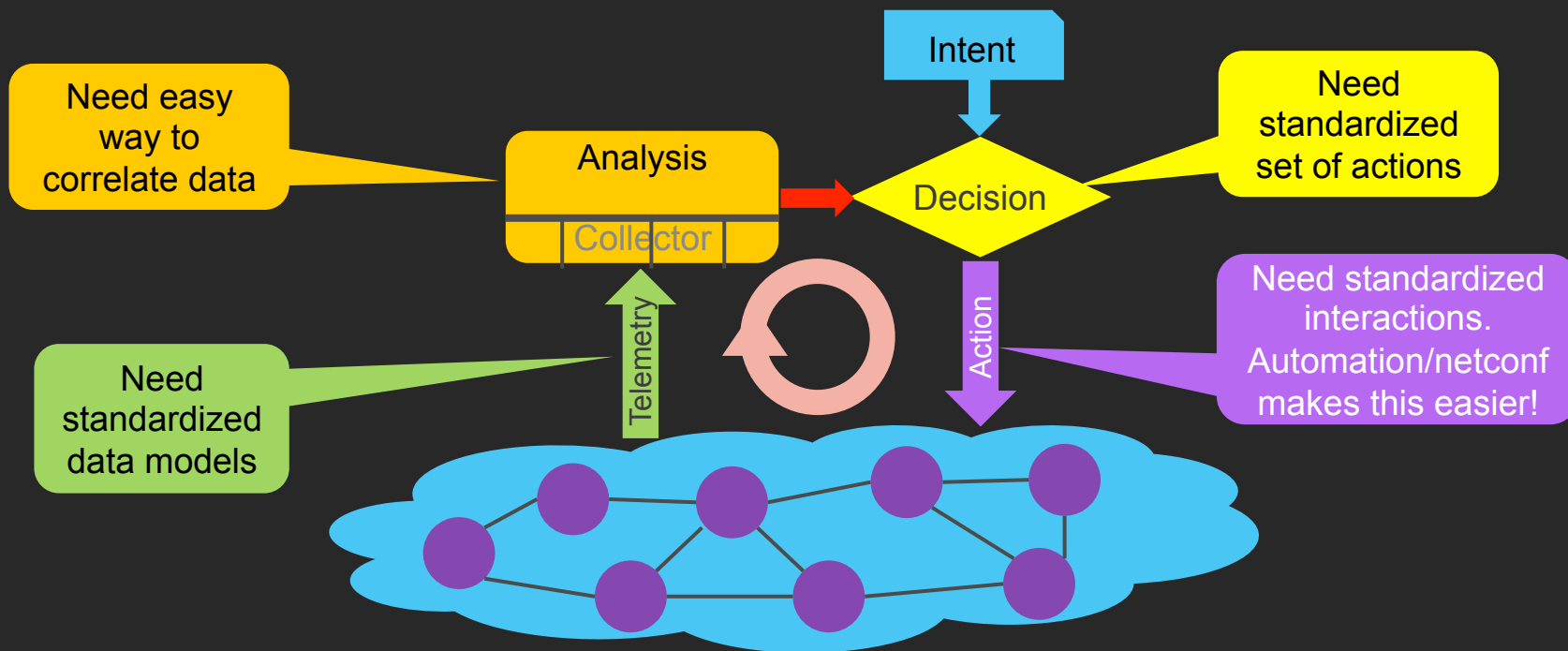
IMPACT:



POSSIBILITIES



HIGH-LEVEL ARCHITECTURE: (nearly) Closed Loop Control



THE SELF-DRIVING NETWORK: GRAND IMPACT (plus)

- Skill set change:
 1. Network geeks → service designers
 2. BGP policies → AI policies
- The network gets out of the way!
 - SLAs are automatically met
- Networks adapt, react, anticipate
 - Learn behavioral patterns
- Security becomes Good Guy 'Bot versus Bad Guy 'Bot



THE SELF-DRIVING NETWORK: GRAND IMPACT (**minus**)

- "Mad robot" syndrome
 - Self-driving = loss of control?
 - Human augmentation rather than full autonomy?
- Impact on net neutrality, privacy
 - How much data is too much?
 - Tracking behavior patterns → abuse?
- Job loss ... big issue, not just for networking



THE SELF-DRIVING NETWORK: GRAND POSSIBILITIES

Super Bowl LX in 10 years

IT infrastructure orders
and delivers itself, then
self-organizes on-site



CONCLUSION



We have before us a compelling vision in networking, both meaningful and realizable

- Economic imperative: attack the biggest cost in networking – operations
 - Efficiency imperative: spin up resources as needed and optimize their use
 - Agility imperative: bring up new services quickly; predict, anticipate and adapt
 - Security imperative: quickly diagnose, isolate and remove or mitigate threats
- ... and do this all with no human intervention

Let's get to work: study, share data,
research, prototype, standardize, iterate