AI/ML TECHNOLOGY ADOPTION IN NETWORKING

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Juniper Networks | Engineering Simplicity

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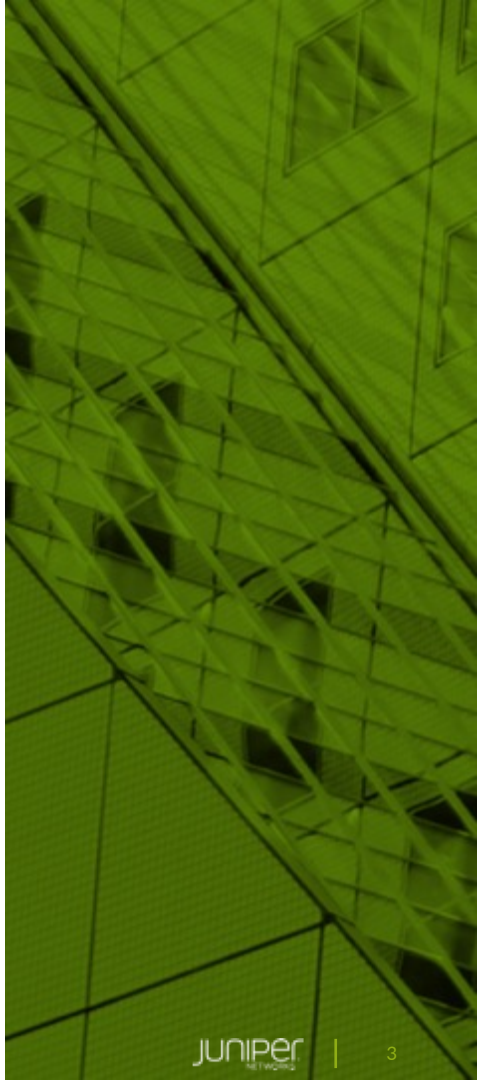
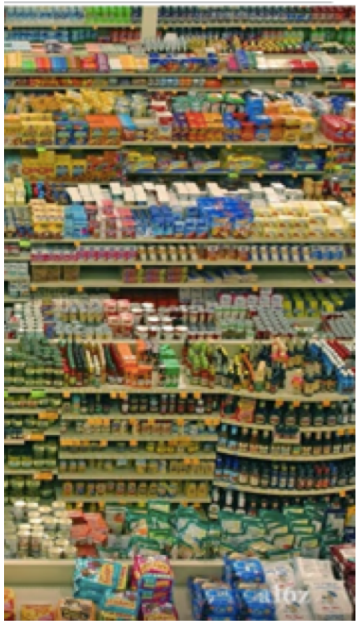
AGENDA

- Artificial Intelligence – A Brief History
- Artificial Intelligence / Machine Learning In Networking
- AppFormix HealthBot – System Health Check
- ML In Action – Multidimensional Capacity Planning (Resource-IQ)
- Bigger Picture - Our Vision For Self-Driving-Network



Artificial Intelligence is for Optimization - Human Intelligence is for Innovation

Google/Baidu Map's
AI-powered prediction



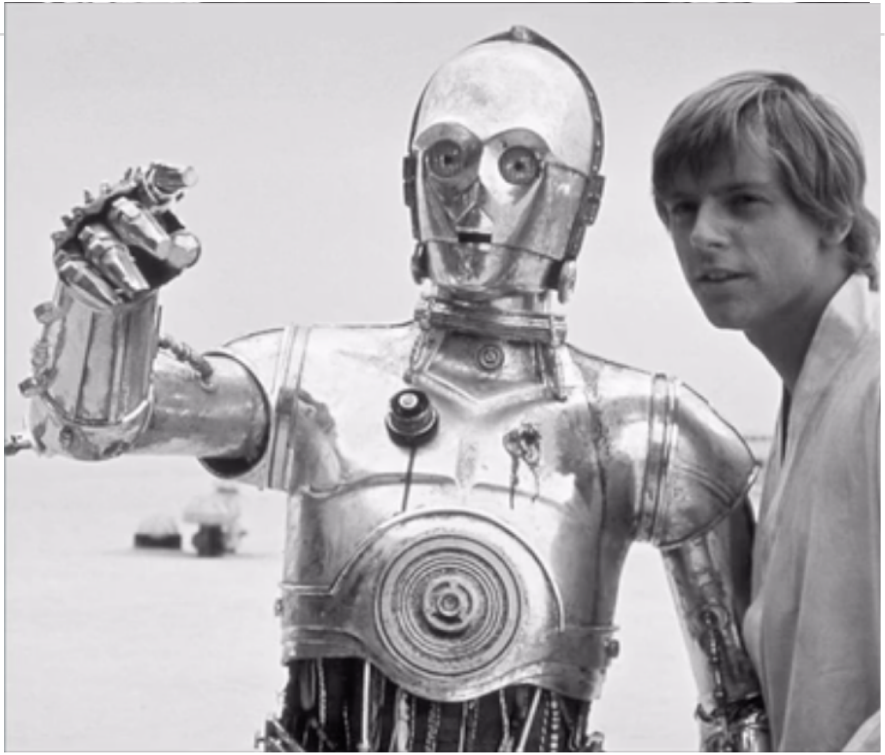
Instacart's grocery
Pick up optimization

JP Morgan Chase's
Contract Intelligence

A Lofty Goal – Generalized Computer Intelligence

- Reasoning – reason like human
- Interact with real world
- Planning (Navigation)
- Natural Language Processing
- Perception

→ Generalized Computer Intelligence



Source: a16z

The Breakthrough in 2012 – Fundamentally Different from Expert Systems

More Compute

1000 computers with 16 cores each ~ 16,000 cores run for a week per experiment

More Data

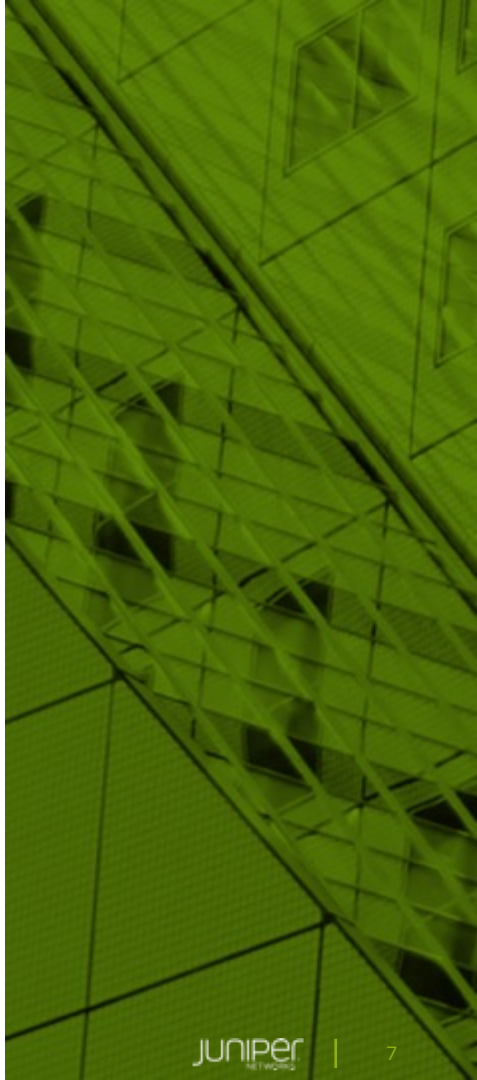
Training set - 10M YouTube Video – 200x200 pixels, thousands of objects in the database

Better Algorithms

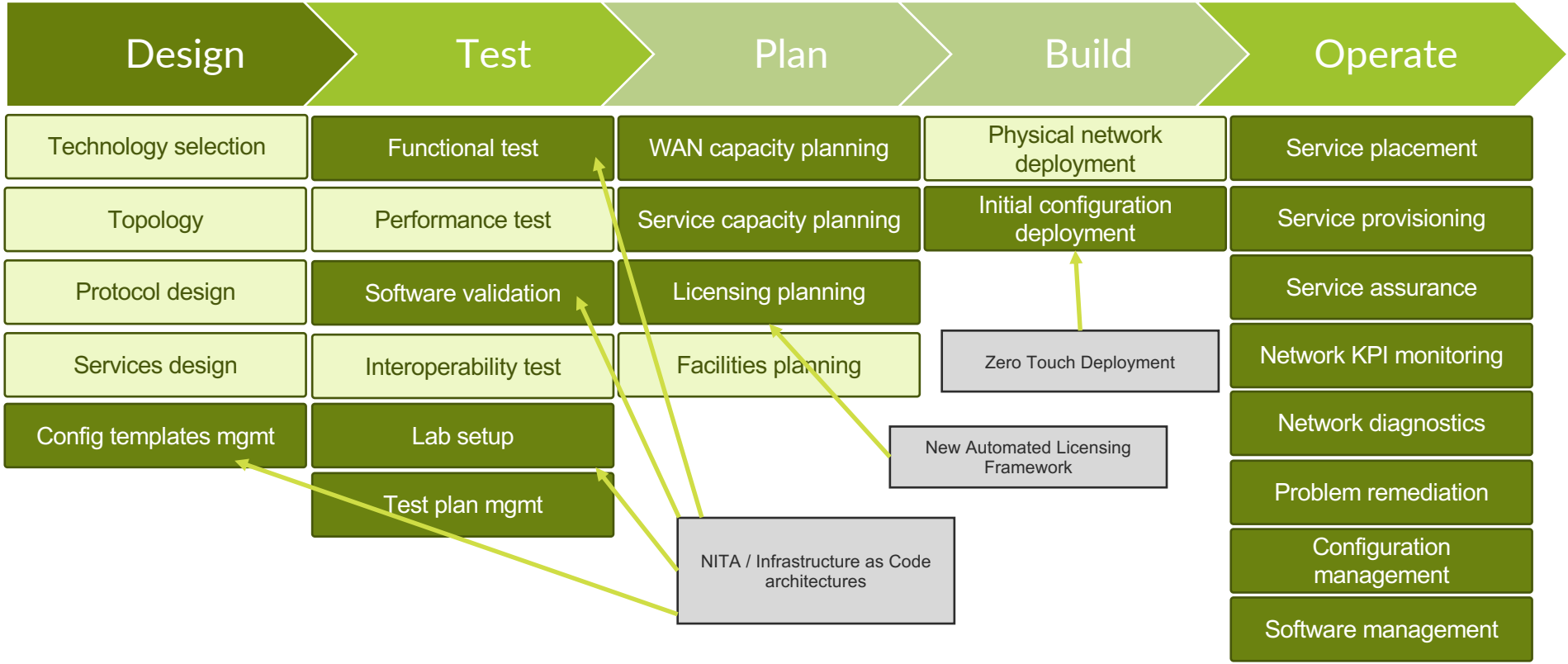
Convolutional, feed-forward, adversarial networks; LSTM

AUTOMATION IN NETWORKING

How Can Machine Learning / Artificial Intelligence Aid Us?



Processes That Require Automation

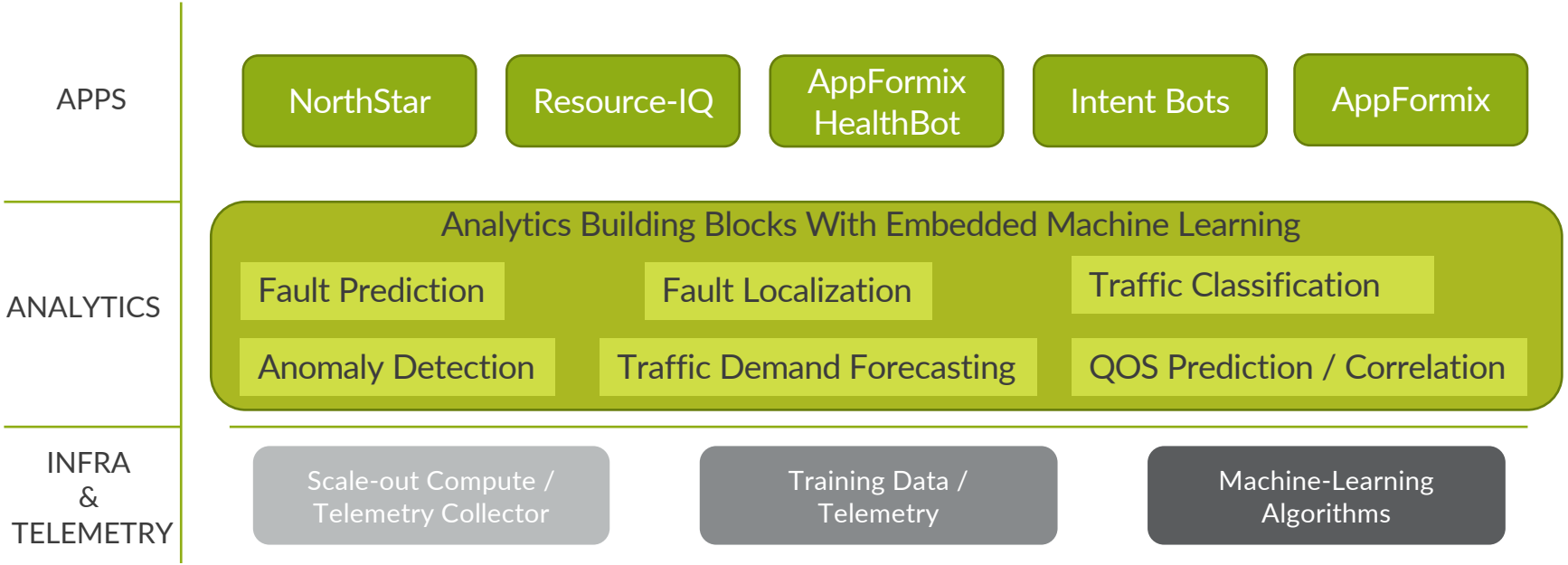


Journey To Self-Driving Network

Process	Today	In the Self-Driving Network	Juniper solutions
WAN Capacity planning and provisioning	Manual setting of paths or distributed traffic engineering.	Analytics based bandwidth allocation, optimization and prediction.	Northstar Controller
KPI monitoring	Manual setting of thresholds.	Dynamic learning of thresholds using ML algorithms.	AppFormix Health Bot
Problem Remediation	Manual analysis and correlation of events, and launch of remediation action (i.e. reset linecard)	ML to learn correlation between conditions and actions taken. Next time the system “knows”	
Problem diagnostic	Manual execution of diagnostic steps.	Automated execution of diagnostic workflows.	
Capacity planning	Sub-optimal multidimensional capacity planning.	ML based predictive models for resource consumption in multidimensional scenarios	ResourceIQ
Service placement	Manual decision of service instance allocation (i.e. PE for a VRF)	Intelligent placement of services based on network telemetry & state.	Contrail Intent Bots
Operationalize automation	Manual process of distributing and executing automation (diagnostics, data collection, etc.)	Automated process to distribute ephemeral micro-services	Next-Gen Service Now.

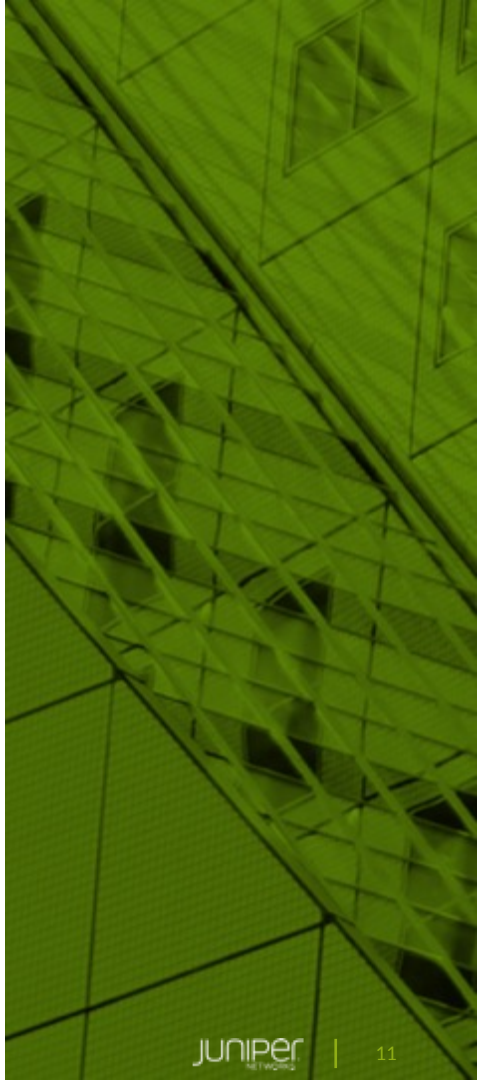
AI / ML In Networking Analytics
Goals - Service Velocity, Simplicity, Human Experience

RE-IMAGINING NETWORKING



APPFORMIX HEALTHBOT

Health Check of Networking Devices Based On Playbooks



INSIGHTS APPLICATION – APPFORMIX HEALTHBOT

Lots of possible use cases (BYOUC)

1	Traffic black hole detection	Detect the existence of an anomalous traffic drop on PFEs or Fabrics.	
2	BNG Health Monitoring	Assessment of multiple BNG health KPIs to evaluate overall system condition.	
3	Microburst detection	Identify the existence of traffic bursts that may result in traffic drops	
4	PFE Wedge conditions	Identify the existence of errors on PFEs that lead or predict the existence of a PFE Wedge	
5	Routing protocols diagnostics	Monitor and evaluate behavior of different routing protocols and identify root cause of anomalies	
6	Routing table health analysis	Evaluate routing and forwarding state and identify anomalies	
7	Capacity planning rules compliancy	Enforce capacity planning rules and detect anomalies.	
8	Service health monitoring	Evaluate end-to-end service health (pseudowires, EVPN, etc.)	

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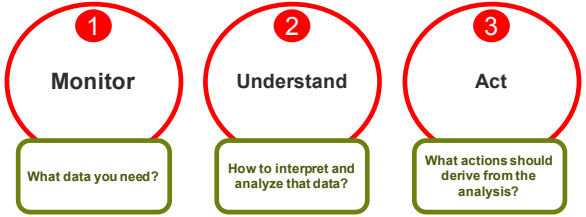
Need to support multiple sources of data. Telemetry and operational state

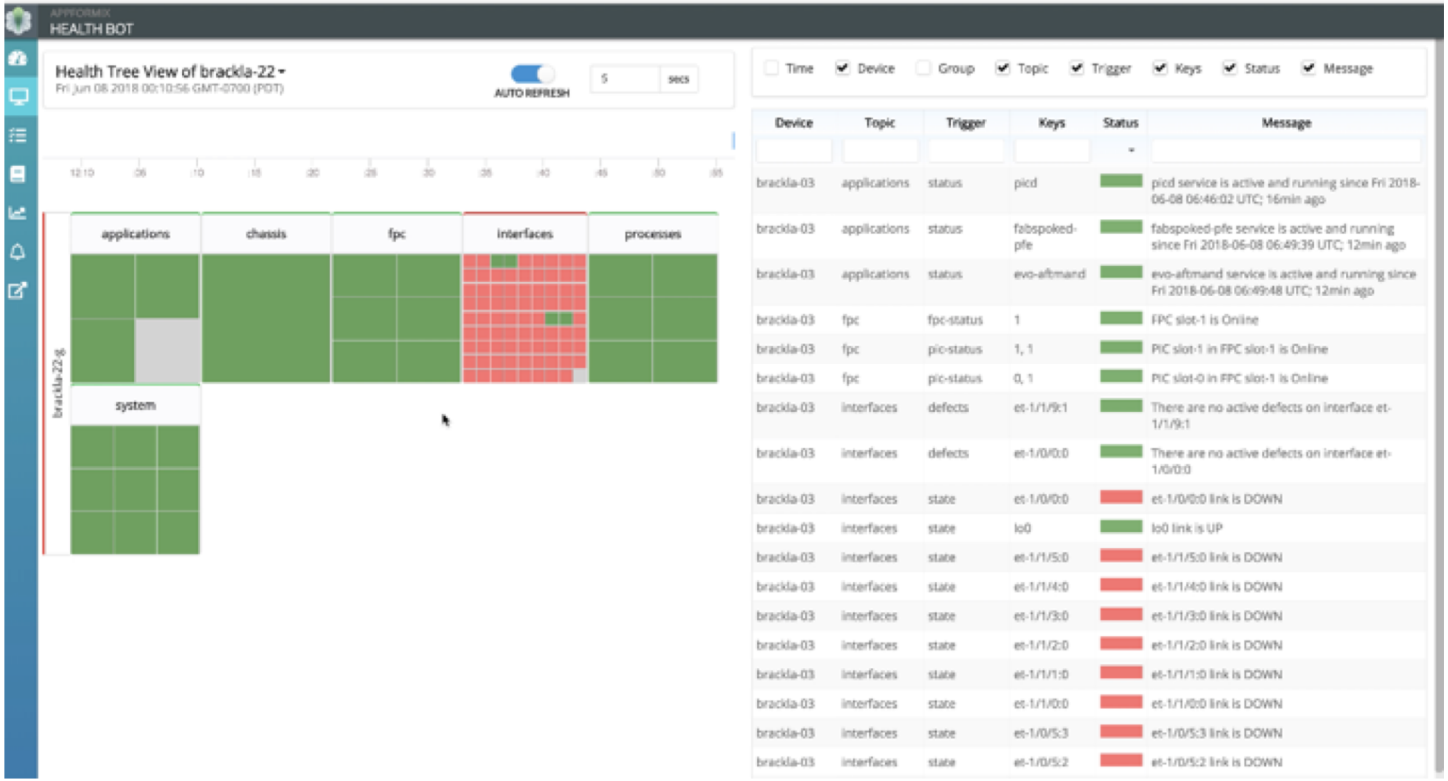
Enable network operation and diagnostics automation



Appformix Healthbot

The programmable network operation and diagnostics tool.

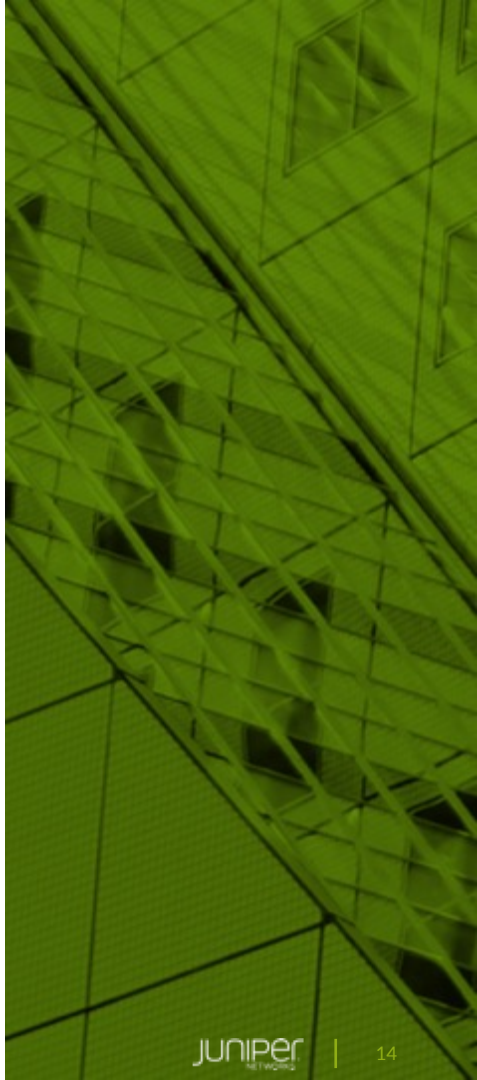
PLAYBOOK BASED HEALTH CHECK OF DEVICES, PROTOCOLS



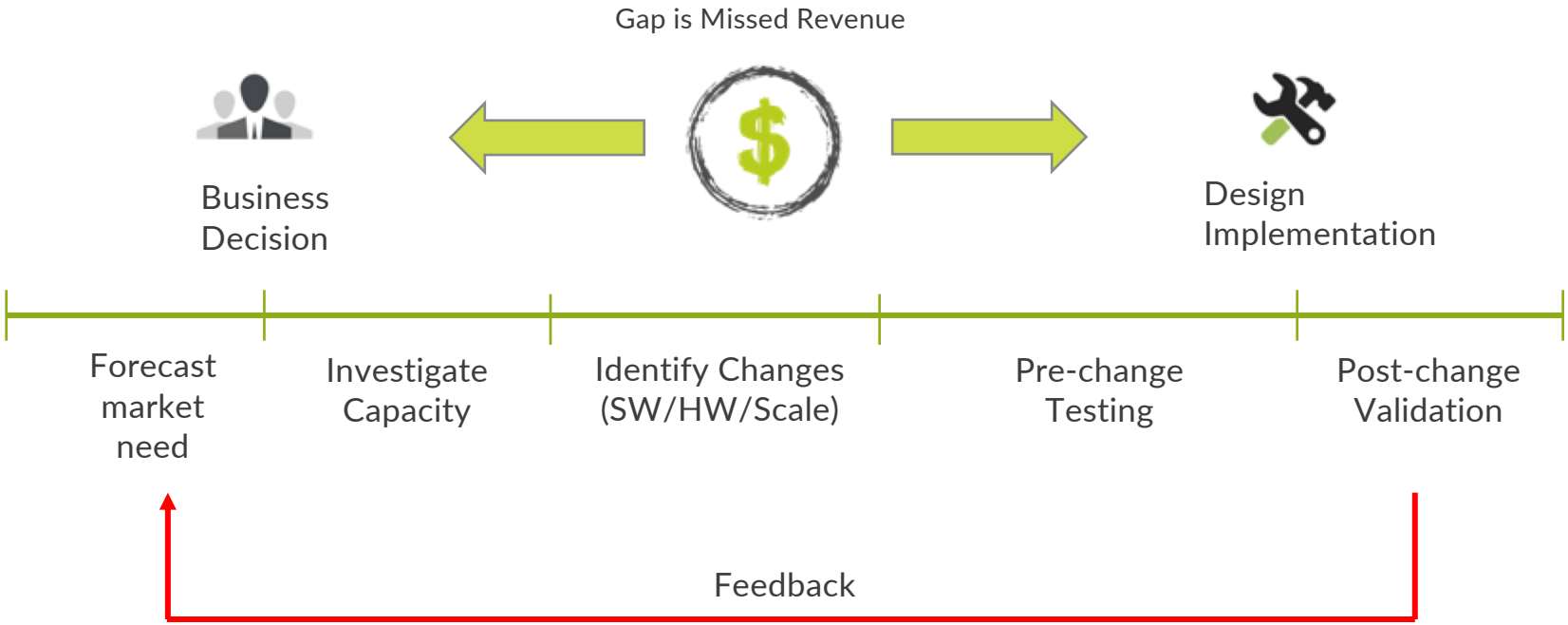
ML IN ACTION – RESOURCE-IQ

Solving An Old problem In A New Way

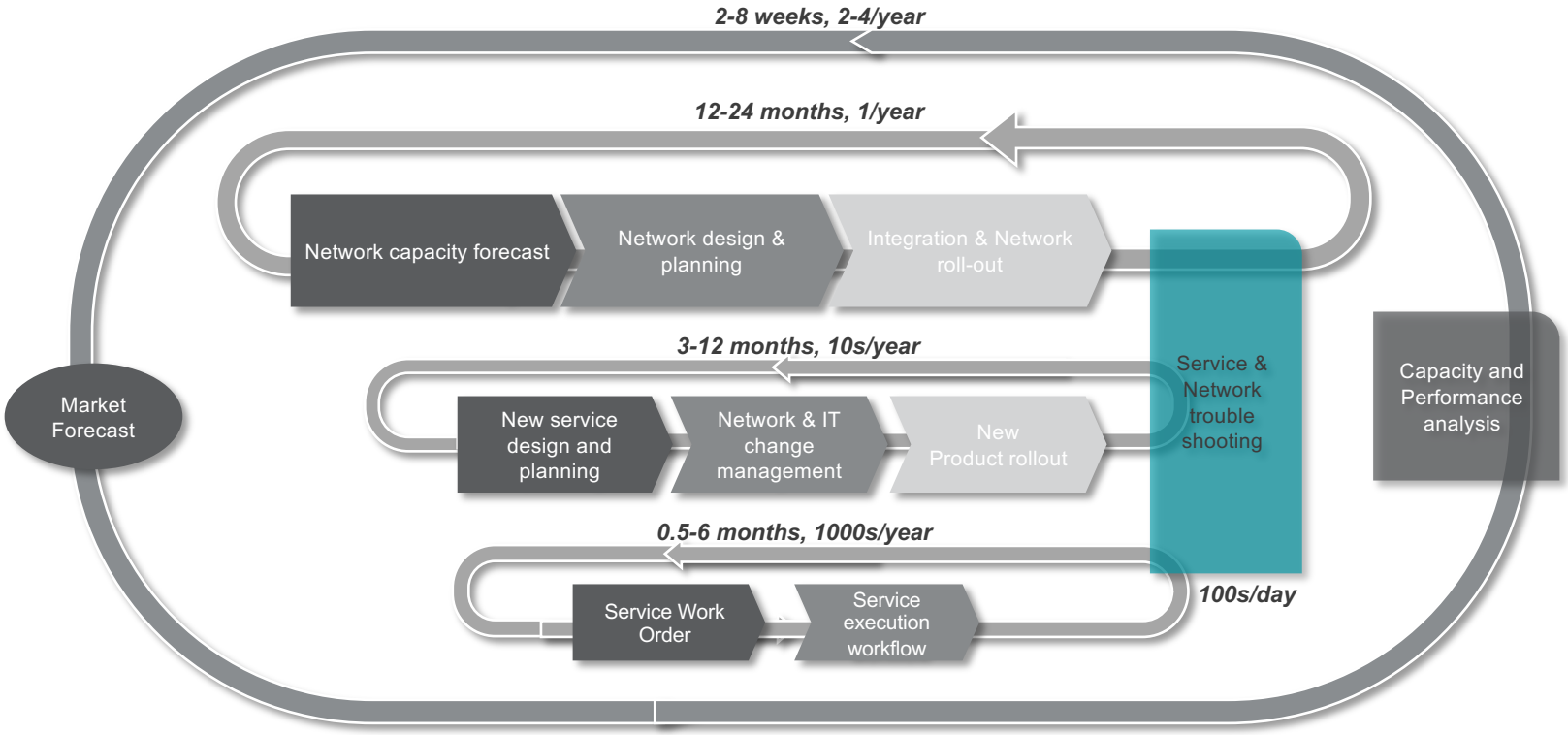
Network Node Capacity Planning Assisted By Machine Learning



Old Problem – Network Change Management Is Expensive



Service Planning and Operation Takes Time



Introducing Resource-IQ – A Data Driven Way to Solve Networking System Resource Planning

Collect Training Data

ResourceIQ starts with customer configuration and uses automated network topology simulation to gather a rich set of telemetry from a networking node

Model & Predict

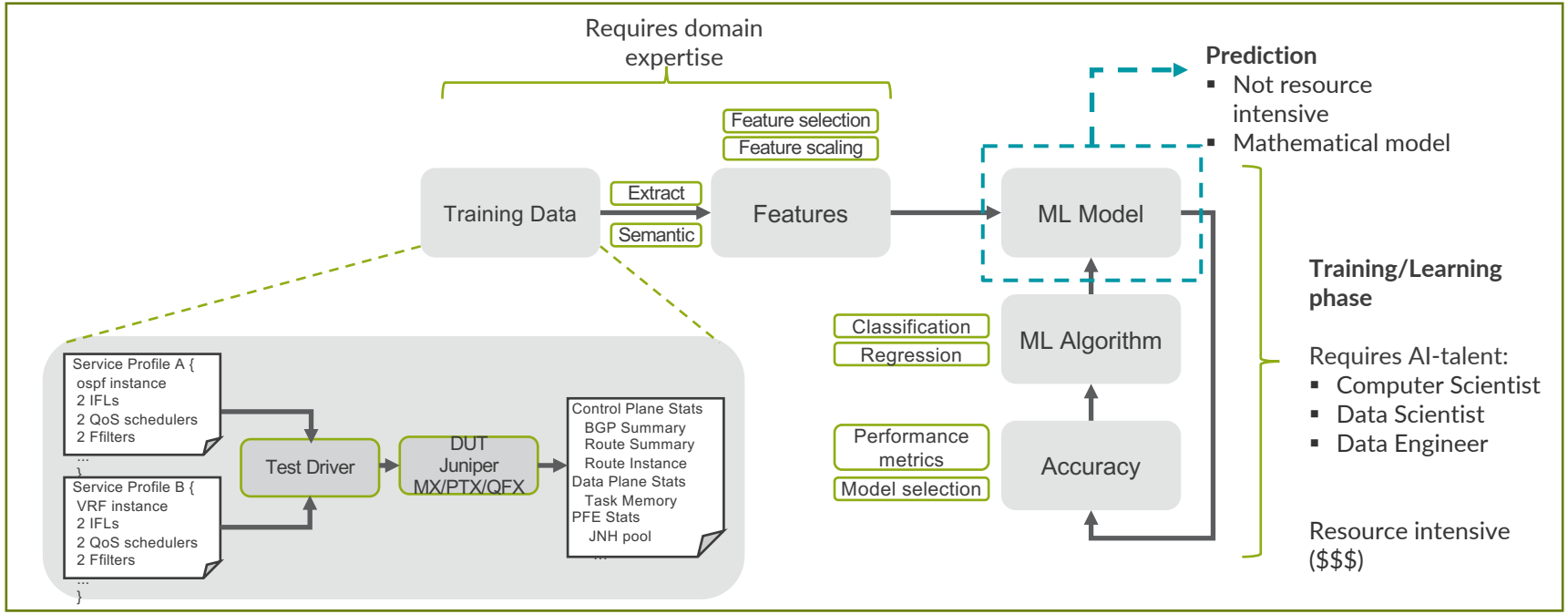
ResourceIQ Machine Learning engine applies mathematical model to learn and predict both routing engine and packet-forwarding engine resource exhaustion under multi-dimensional load

Take Automated Action

Future plan for ResourceIQ is to enable automated and/or operator-approved service execution – our vision for self-driving network

Resource-IQ – A Fundamentally Different Approach

Goal is to build a ML-based resource planning application for a networking node

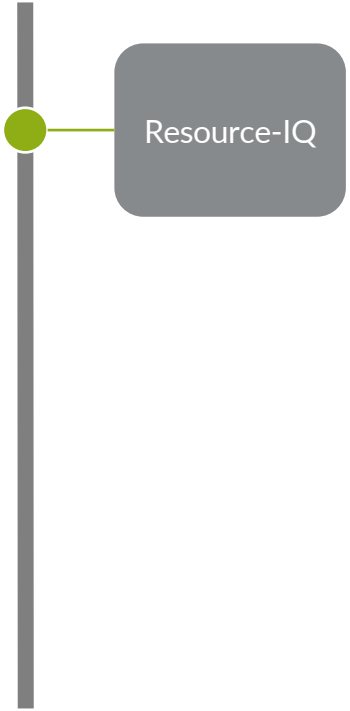


Training Data

Compute scale

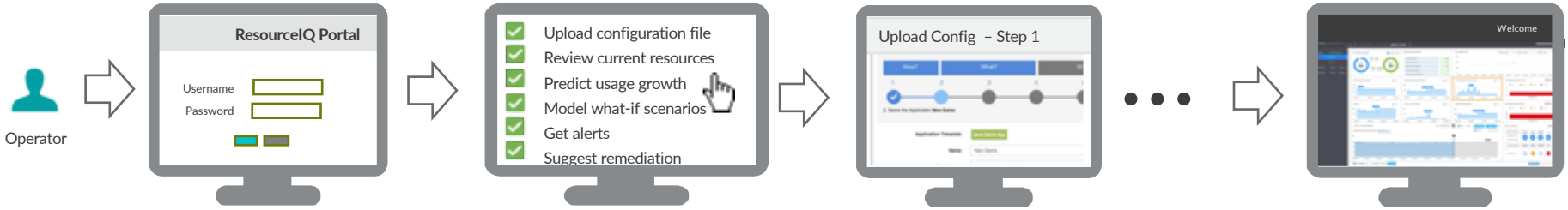
Better Algorithms

Resource-IQ – Overview



- What it is?
  - A Machine Learning-based service planning application for a networking node
- What does it do?
  - Models network services and predicts resource exhaustion of critical parameters of a networking node
- Who is it for?
  - Targeted towards Network engineers/architects/planners of all customers (Initial target vertical -Telco, Cable, Hosting, …)
- How does it help end-users?
  - Models and predicts resource before a major software upgrade
  - Models and predicts resource before introducing a new line-card/RE
  - Predicts capacity of networking gear as network services scale
  - Predicts capacity of a new node as network services converge/migrate and network hierarchy collapses
  - Predicts host resource exhaustion with NFVi (vMX, vSRX) services
- How does an end-user access it?
  - Web UI, no on-premise data collection

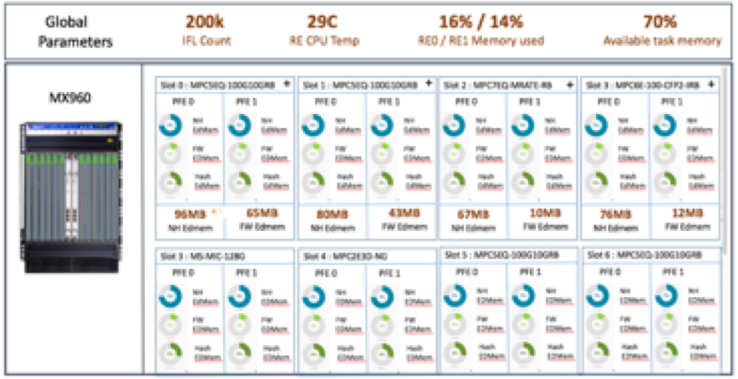
User Workflow



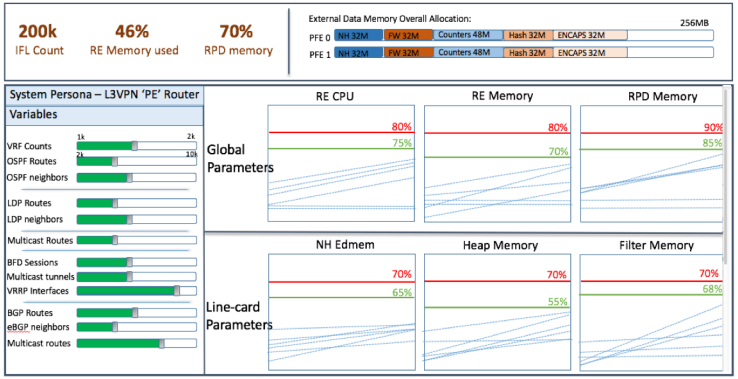
Some services can run in the Juniper Cloud,
Other services can run on-prem

JUNIPER SAAS SERVICES

MONITOR



PREDICT



Three Main Steps : More Data, More Compute, Discover Algorithms

Training Data

We don't have 10M YouTube Video.
Initial Approach : Use Customer Network

PROBLEMS :
- Huge Scale, Low Variance
- Need high-frequency collection to train
- New scenario (Line-card, Junos version) unavailable
- No central telemetry collector

SOLUTION :

- Build a high-entropy Monte-Carlo simulator for network
- Vary all input parameters to get a statistically significant training set

Scale-Out Compute

We don't need 1000 computers.
We do need scale-out compute to process
- CLI/Text
- NetConf/XML
- Syslog

SOLUTION:

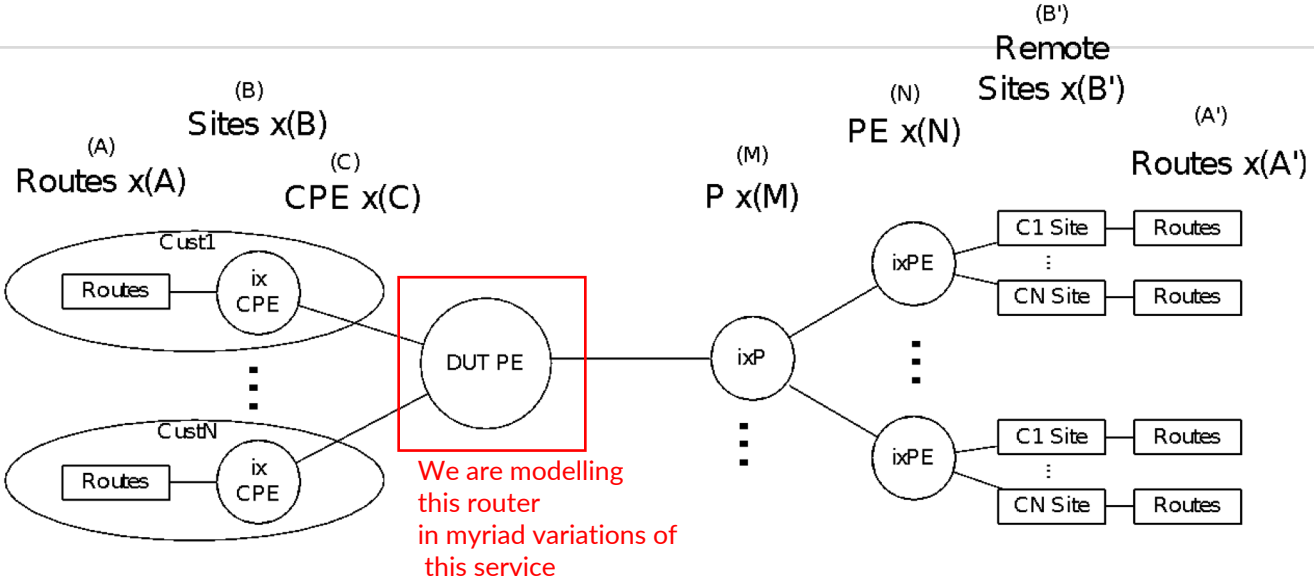
Kafka-based Telemetry Orchestrator
Apache Spark based ETL
Cassandra database
ElasticSearch / Logstash

Better Algorithms

Data cleaning – Null value filtering
Training set preparation
Dimension Reduction / feature selection
- Principal Component Analysis
- Intuitive for end-user

Supervised Learning
For speed – Linear Regression
For accuracy – Gradient boosting regression
- Handles Nonlinear relationship between input features and target

Step 1 : Generate Training Data (L3VPN example)



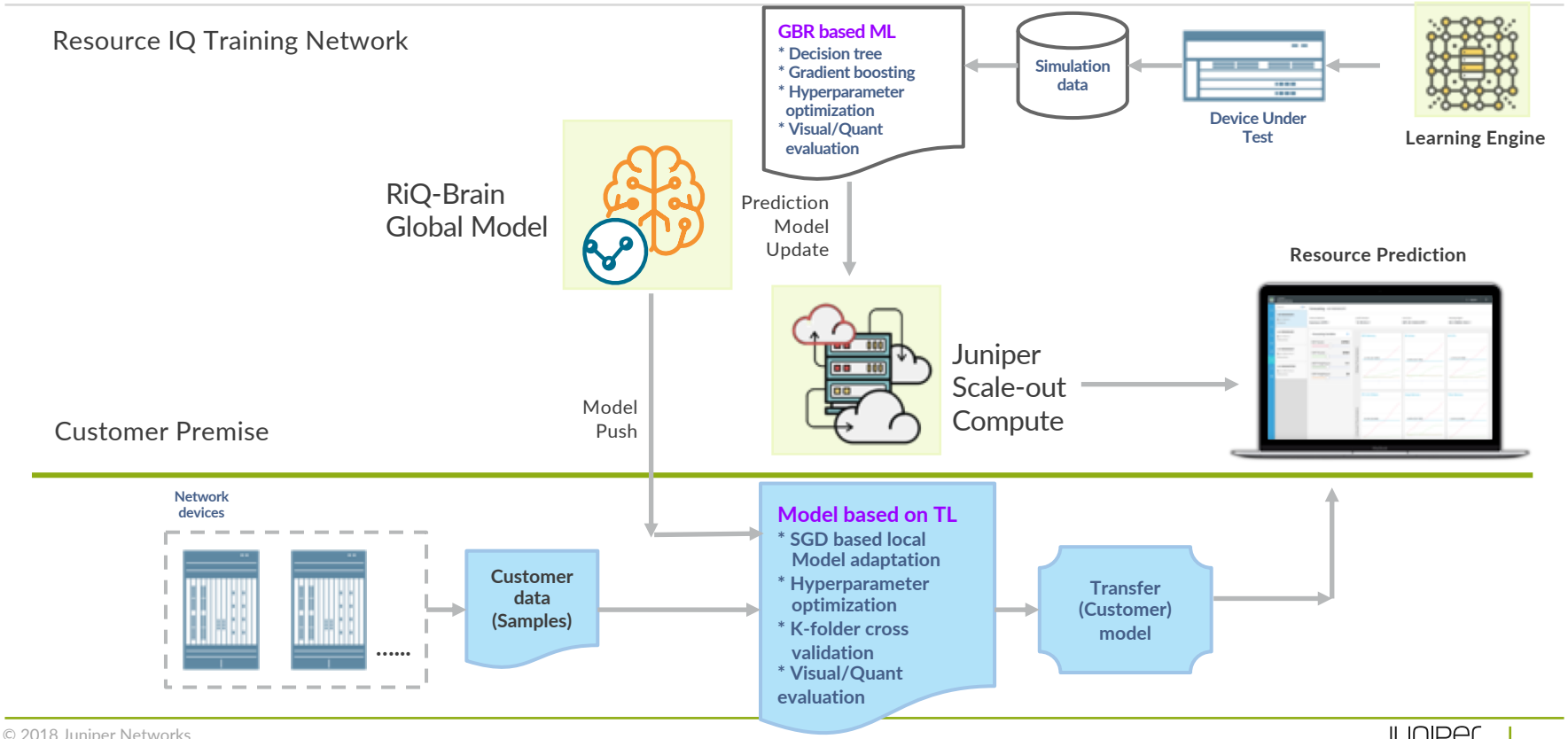
A = # of access routes per CPE
B = # of access sites
C = # of CPE per site

M = # of P routers
N = # of remote PE routers
B' = # of sites per remote PE
A' = # of routes per Site

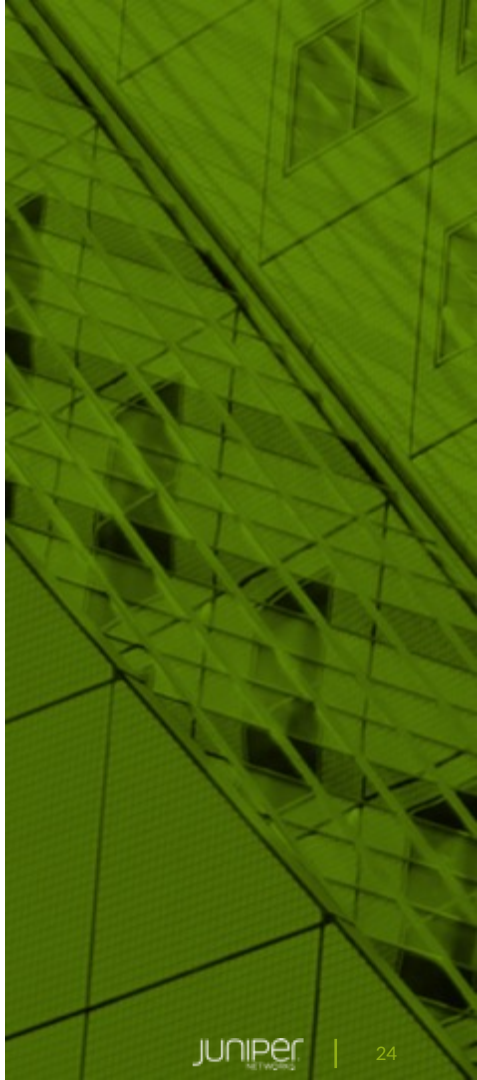
CPE to PE protocol: eBGP, iBGP, OSPF
(Mutually exclusive except where needed)

Total Routes: (A*(B*C))+(N*(B'*A'))
Total CPE Routes: (A*(B*C))
Total Remote Routes: (N*(B'*A'))

Step 2 & 3 : Build ML Model, Measure and Iterate



RESOURCE-IQ DEMO



MONITOR

JUNIPER RESOURCEIQ

Log out ?

Search

re0-NMAMADR1
15.1R6-S2.1
Madrid

re1-NMAMALB2
15.1R6-S2.1
Barcelona

re1-NMAMAGA7
14.1X50-D145.3
Barcelona

re1-NMAMAPEN6
14.1X50-D145.3
Barcelona

Monitor - re0-NMAMADR1

200K	46%
IFL Count	RPD Memory
59%	**73%**
RE Memory Used	Task Memory

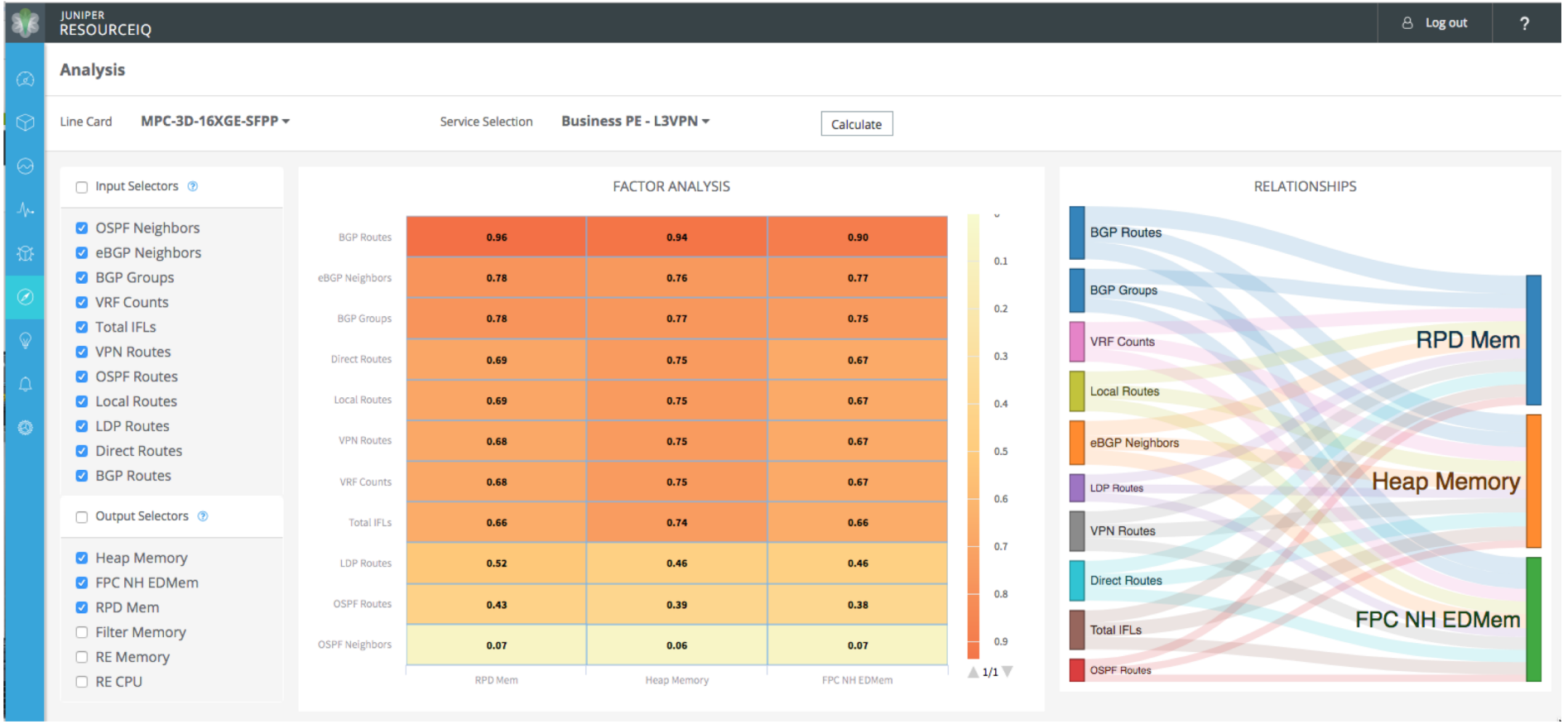
Line Card Monitoring

#01 MX-MPC2-3D-Q		#02 MPC-3D-16XGE-SFPP		#03 MPC5EQ-100G10GRB		#04 MPC5EQ-100G10GRB	
NH EDMem	70% 45 MB (0–64)	NH EDMem	70% 45 MB (0–64)	NH EDMem	70% 45 MB (0–64)	NH EDMem	77% 49 MB (0–64)
FW EDMem	63% 40 MB	FW EDMem	63% 40 MB	FW EDMem	63% 40 MB	FW EDMem	67% 43 MB
Hash EDMem	50% 32 MB	Hash EDMem	50% 32 MB	Hash EDMem	50% 32 MB	Hash EDMem	59% 38 MB

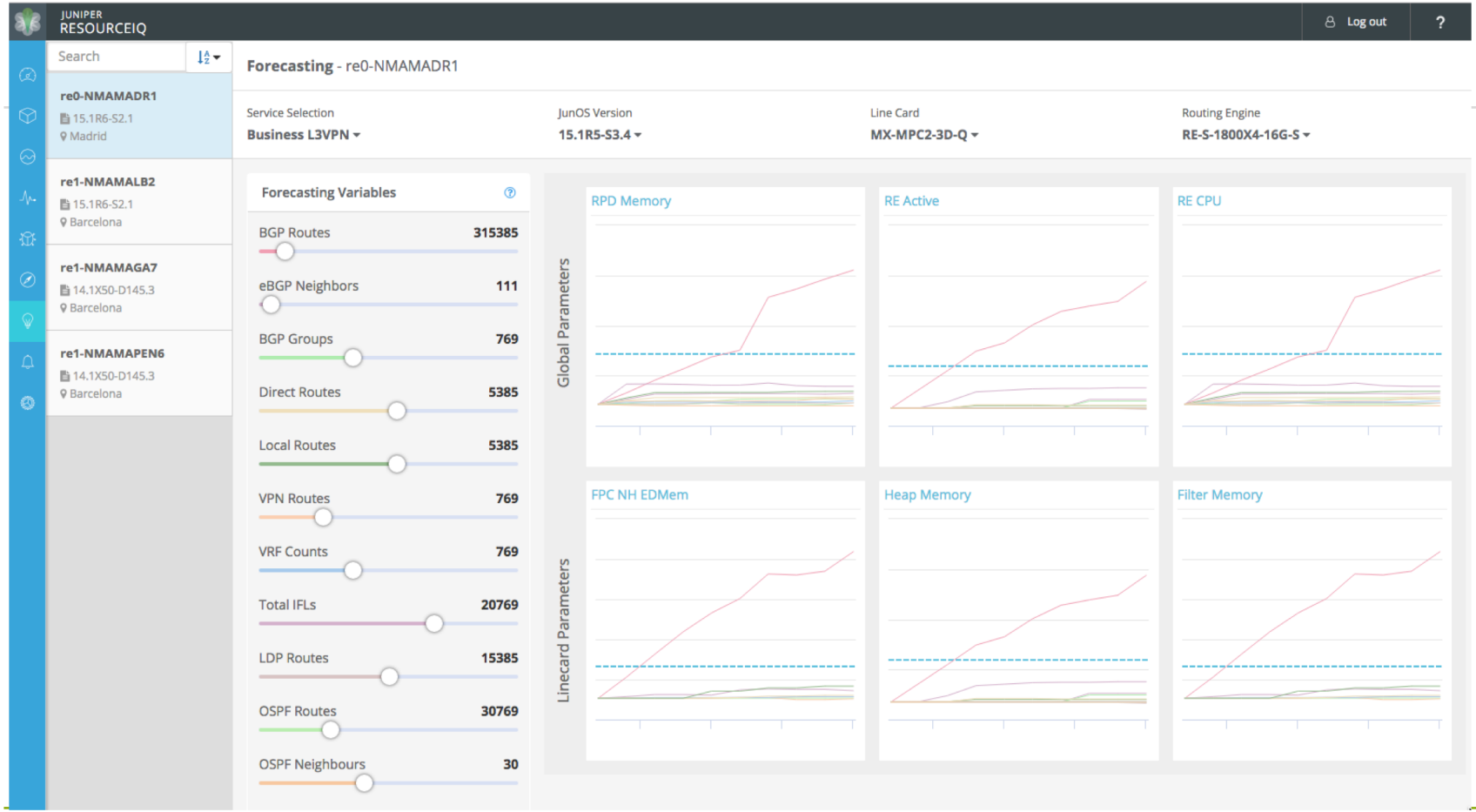
#05 MPC7EQ-MRATE-RB		#06 MPC6E-100-CFP2-IRB		#07 MS-MIC-128G		#08 MPC2E3D-NG	
NH EDMem	81% 52 MB (0–64)	NH EDMem	78% 50 MB (0–64)	NH EDMem	86% 55 MB (0–64)	NH EDMem	70% 45 MB (0–64)
FW EDMem	53% 34 MB	FW EDMem	55% 35 MB	FW EDMem	67% 43 MB	FW EDMem	63% 40 MB
Hash EDMem	44% 28 MB	Hash EDMem	44% 28 MB	Hash EDMem	53% 34 MB	Hash EDMem	50% 32 MB

#09 MPC5EQ-100G10GRB		#10 MPC5EQ-100G10GRB		#11 MPC7EQ-MRATE-RB		#12 MPC6E-100-CFP2-IRB	
NH EDMem	66% 42 MB (0–64)	NH EDMem	70% 45 MB (0–64)	NH EDMem	80% 51 MB (0–64)	NH EDMem	92% 59 MB (0–64)
FW EDMem	61% 39 MB	FW EDMem	63% 40 MB	FW EDMem	56% 36 MB	FW EDMem	47% 30 MB
Hash EDMem	47% 30 MB	Hash EDMem	50% 32 MB	Hash EDMem	41% 26 MB	Hash EDMem	38% 24 MB

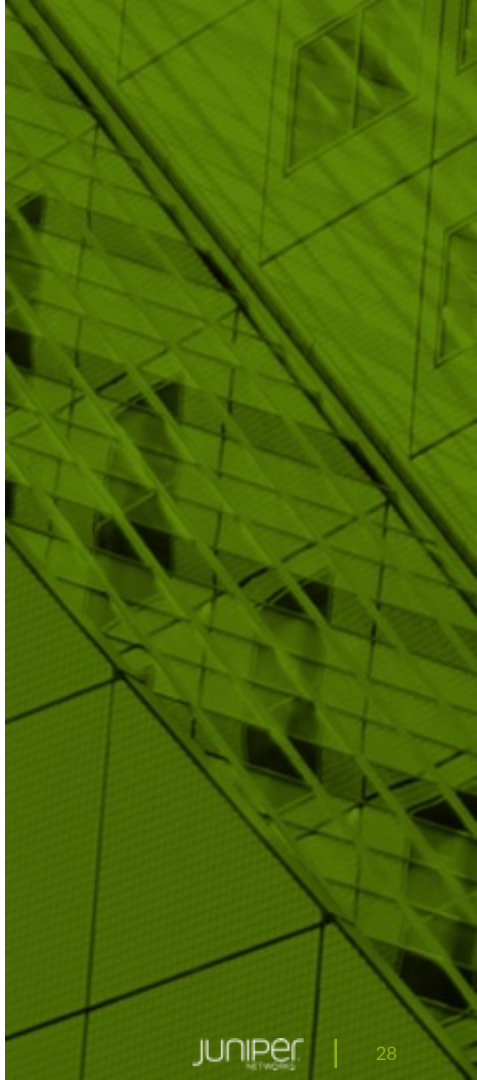
ANALYZE



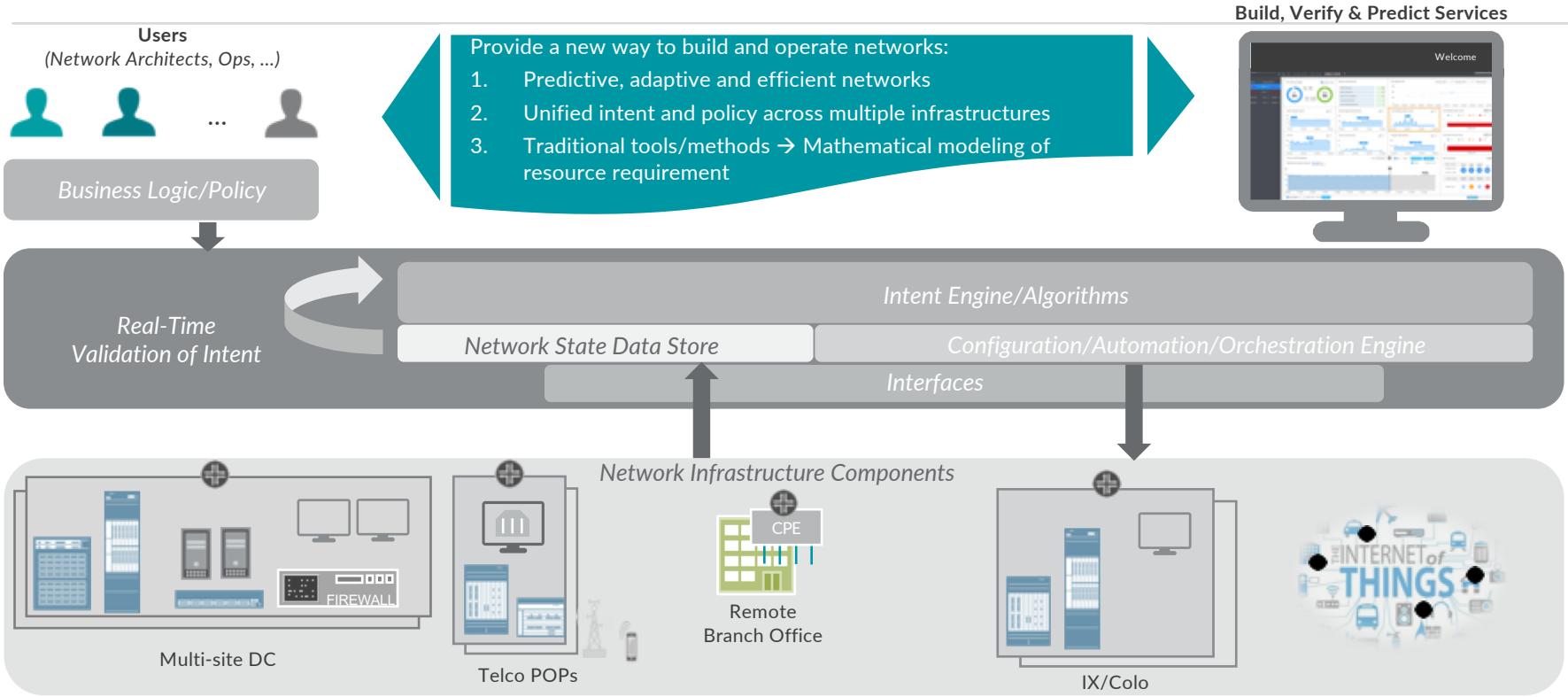
PREDICT



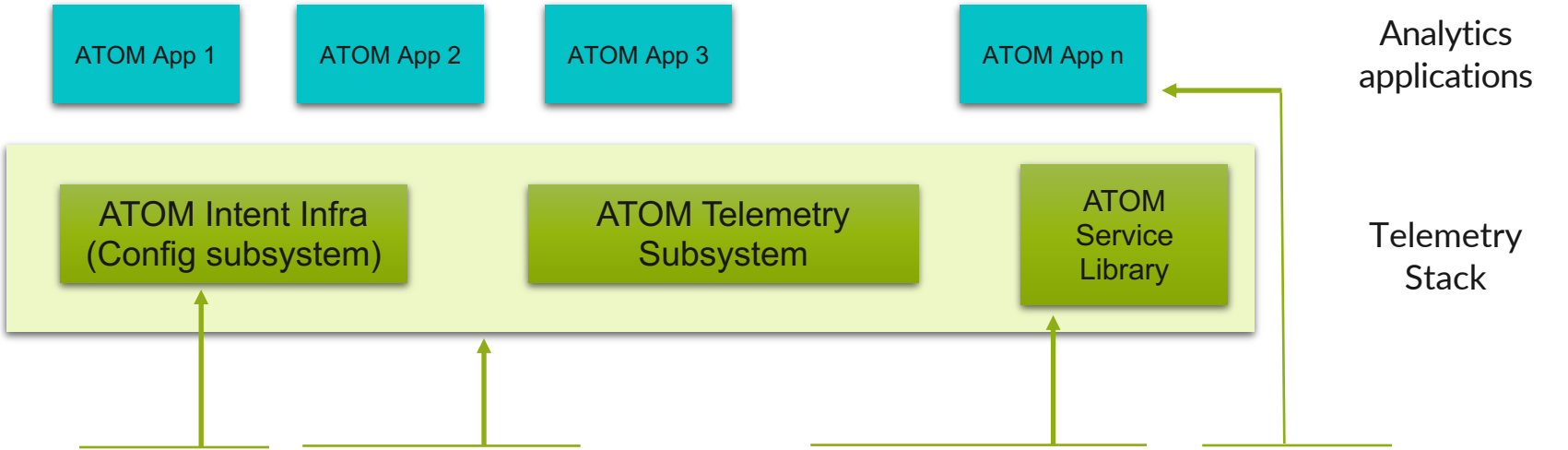
BIG PICTURE – OUR VISION FOR SELF-DRIVING NETWORK



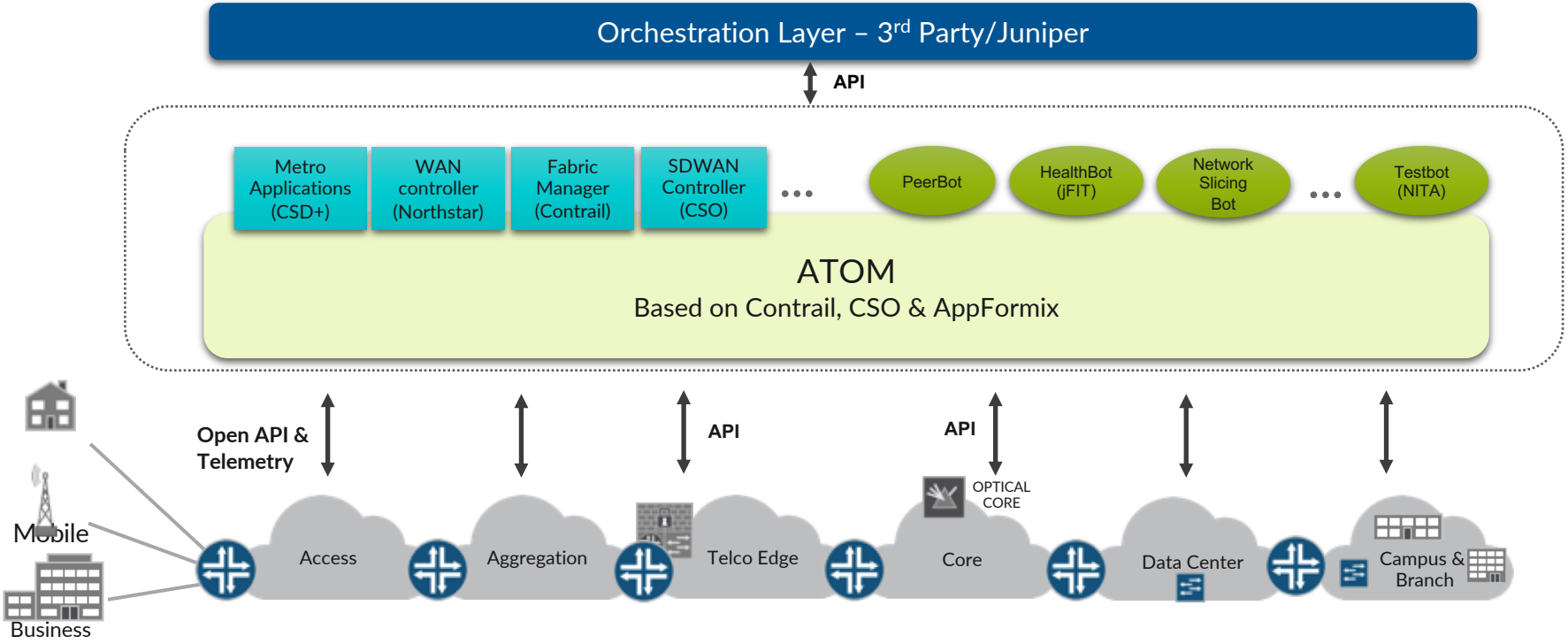
Our Goal – Intent Based Networking



We Are Investing In Common Stack For Analytics, Telemetry, Orchestration, Management (ATOM)



ATOM Ecosystem Vision

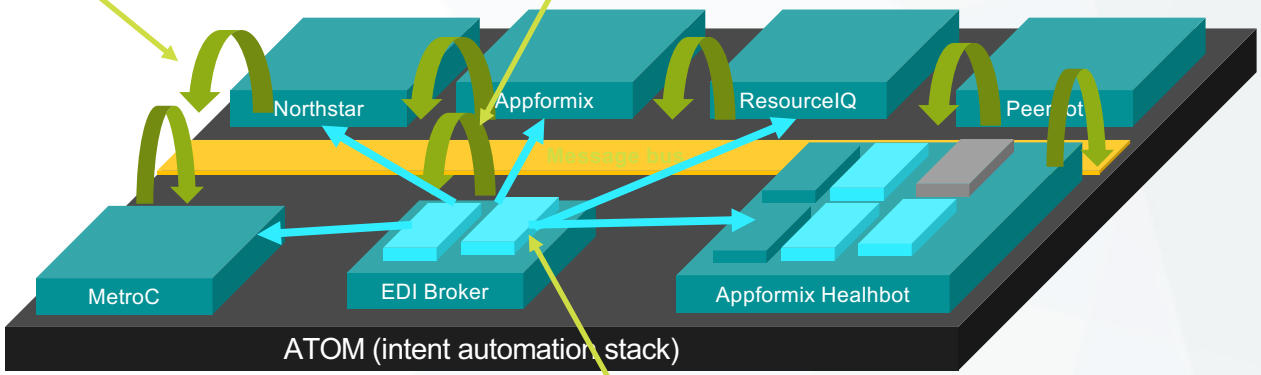


In planning

Enabling Event Driven Automation In ATOM

EDI Broker consumes the events and telemetry it is interested on

Application events published on the bus



EDI Broker calls app specific APIs based on programmed workflows

SUMMARY

- SP and Cloud transformation driven by network orchestration and automation
- Advanced compute and captured telemetry from devices are essential ingredients to build intelligent applications for self-driving network
- Artificial Intelligence and Machine Learning will be embedded in all future smart applications
- Our goal is to partner with Service Providers in this automation journey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