Intelligent Resiliency for a Converged World

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Agenda

1. Emerging Technology
2. AT&T Network Overview
3. AT&T Network Transformation
4. Challenges to Reliability
5. Building Operational Resiliency
6. Conclusions
Emerging Technology
Living in a Connected World

Massive connectivity, higher speeds and lower latency will create opportunities with many new use cases and transform how data and content is consumed.
Interoperability Standardization

Highly Secure Software Management

Improved Sensor Technology

29B
Expected things connected to the Internet by 2022

~4x
Projected devices than the world’s population

$1+ Trillion
Anticipated value of IoT in only a few short years
IoT 5G SDN

10–100x

Ultimate future expected 5G speeds compared to 4G LTE

1–5 ms

Ultimate future expected 5G latency range

Based on ITU IMT-2020 Requirements
**Service Design & Creation**

10x

Expected total AT&T network traffic growth by 2020

*274 PB

Data traversing AT&T’s network daily

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* As of 2Q 2019

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AT&T Network Overview
Foundation for a Connected World

The Railroad Industry
- Rapid business expansion
- Surge in trade
- Increased competition

1838 - 1853

The Networking Industry
- Radical globalization & modernization
- Increased pace & reach of change

1995 - 2010

17x
40x
Build the best network – global reach and consistency

- Multi-protocol Label Switching (MPLS)-based services* available to 204 countries over 3900+ nodes
- Dedicated Ethernet access in 169 countries

- 1,285,148 fiber route miles globally
- 1,474,765 wavelength miles of 40 Gbps
- 1,448,267 wavelength miles of 100 Gbps

- AT&T Remote Access Services customers: 1,462,724 total points in 146 countries
- 1.4M+ WiFi Hotspots in 146 countries
- Wired Ethernet access (hotels) in 36 countries via 390+ access points
- Dial-up available in 36 countries

The AT&T Global Network carries more than 274.6 Petabytes of data traffic on an average day
AT&T Network Transformation
Tremendous Traffic Growth

- Traditional build **not pacing** with demand
- **Software-centric** scales faster

2019: **274** PETABYTES DAILY
2015: **114** PETABYTES DAILY
Current hardware-centric path is unsustainable

Projected traffic growth by 2020 10X

HW centric network design and build Linear scale

SW centric network design and build Hyper scale
NFV & SDN Overview

1. Network Function Virtualization
   - Physical functions become virtual
   - Greater reuse & distribution

2. Software Defined Networking
   - Intelligent – autonomous & automated
   - Reliable & secure – greater extensibility & control
Transition from purpose-built network appliances

Managing via Global & Local Software Controllers

Open network functions from stand-alone software components

Virtualized & controlled Infrastructure

Transition from purpose-built network appliances
Challenges to Reliability
re·li·a·bil·i·ty | /reˌliːˈbilədē/ noun:

1) the quality of being trustworthy or of performing consistently well

2) the degree to which the result of a measurement, calculation, or specification can be depended on to be accurate
The Power of “9”

99.9999%  “Six-nines” $\leq$ 32 seconds

99.999%   “Five-nines” $\leq$ 5 minutes, 15 seconds

99.99%    “Four-nines” $\leq$ 52 minutes, 36 seconds

99.9%     “Three-nines” $\leq$ 8 hours, 46 minutes

99%       “Two-nines” $\leq$ 3 days, 15 hours and 40 minutes

9%        “One-nines” $\leq$ 332 days

Note: All timeframes are downtime on a per year basis
## Challenges to Maintaining Reliability

<table>
<thead>
<tr>
<th>Component</th>
<th>OSS Apps</th>
<th>BSS Apps</th>
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<tbody>
<tr>
<td>ECOMP</td>
<td>ORM</td>
<td>MSD</td>
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<td>SDN-G</td>
<td>A&amp;AI</td>
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<td>VNF</td>
<td>Mobility</td>
<td>Voice</td>
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<td>XaaS</td>
<td>DBaaS</td>
<td>QaaS</td>
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<td>NC (Cloud)</td>
<td>Compute</td>
<td>Network</td>
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<td>SDN Local</td>
<td>VXLAN</td>
<td>Service Chain</td>
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<td>HaaS</td>
<td>MaaS: Ubuntu</td>
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<tr>
<td>NW / HW</td>
<td>TOR</td>
<td>TOA</td>
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<td></td>
<td>Compute</td>
<td>Network</td>
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</tbody>
</table>

### Complexity

- **30+ Software Components** – Orchestrating VNFs
- **1000’s** of AT&T Proprietary and vendor provided VNFs
- **100+ Configurations / Permutations** of AT&T Cloud
- **1000’s** of devices, **Multiple** vendors, multiple support models
Cloud SW Versions (4)

- Host / VM Flavors
  - CPU Pinning | NUMA, SRIOV | DPDK | etc.

- Storage Types
  - Solidfire | Pure | Hitachi | Various Models

- Deployment Types
  - Brownfield | Greenfield | Rack Expansion

- Server Types
  - Dell 720 | Dell 730 | Dell 820 | HP Gen 8 | HP Gen 9 | 1U | Purley

- Reference Architectures
  - Large DC | Large NTC | Large Normalized | Compact | Medium

~118 Different Cloud Layer Implementations

1 - Cloud must abstract this from ECOMP/VNFs
2 - Technology will continue to evolve
3 - Must make these changes with production traffic
4 - Need to evolve Cloud/ECOMP at the same time
5 - Must need many, diverse dev/test environments
Resilience by Design

Reliable Network Traffic

Resilience

Building resilience into the underlying infrastructure stack, its process and operations enables us to reduce downtime to our customers and increase reliability.
Building Operational Resiliency
resilience | /rəˈzɪlɪəns/ noun:

1) the capacity to recover quickly from difficulties; toughness

2) the ability of a substance or object to spring back into shape; elasticity
Operational Resiliency Risk Mitigation Automation

Configuration Validation as a Service (CVaaS)
- Pre-Provisioning, Post Provisioning & Change Management and Life Cycle
- Self-Serve Design Studio for Validation Rules/Policy
- Closed Loop Discord Remediation

Change Management Deconfliction
- Topology and Service Infrastructure Path
- Correlation of Alarms and Planned Change Management on Service Path
- Recommended Schedule for Change Management to minimize Service Disruption

Zero Touch Traffic Migration and Recovery
- Zero Touch Automation of Traffic Migration & Recovery
- Proactive Pre/Post Migration Checks using Passive Monitoring and Active Probes
Configuration Validation as a Service (CVaaS)

**CVaaS** – provides fully automated VNF and Infrastructure Configuration Validation via Validation Rules Programmed using Self Serve Capability

**Life Cycle**

- **Pre-Provisioned Validation**
- **Provisioning and Change Management Validation**
- **In-Service Life Cycle Validation**
Change Management Deconfliction

A rigorous change management deconfliction strategy is essential for network resilience.

- **Topology & Service Path**
- **Recommendation for Optimal Change Management Scheduling**
- **Analytics to Identify Conflicts and Service Disruption Risks**
- **Correlation of Alarms and Change Management Events**

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
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<td>Traffic: Path 1</td>
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<td>Traffic: Path 2</td>
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<td>Outage</td>
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Point A -> Point B

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Zero Touch Traffic Migration and Recovery

Zero Touch Traffic Migration and Recovery is focused on minimizing Operational Manual Intervention

Establish Workflow and Link to Operations Playbook / Scripts (e.g., Ansible)

Site Dry out

Pre/Post Action Checks w/ Passive Monitoring and Active Probes

Roll back

Integration with ECOMP and SDN Controller including logging, alarming...

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“Persistence and resilience only come from having been given the chance to work through difficult problems”

- Gever Tulley