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Automated, Open Meet-Me-Room

Anthony Kewitsch, Ramiro Voicu, Ed Buckley, Mark Wippich
Telescent Inc.

Today: Manual Management of Interconnections

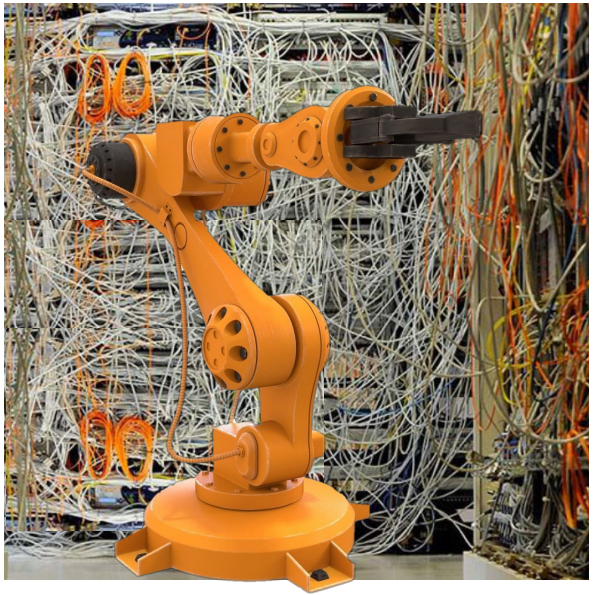
Pain = Operational Problems, Service Limitations, Slow Response Time, Errors

Status Quo:

- Technicians
- 100,000 Manual Connections Per Data Center
- Slow Response Time (Days vs Mins)
- Manual Data Entry

Robot + Patch-Panel is a Hard Technology Problem

Robot Needs to Move Any Connector Out of 1,000s And Carry Fiber Optic Cable Attached it Without Disconnecting/Entangling Others



Technical Challenges:

- Optical Fiber Interconnects Easily Tangle as They Are Reconfigured
- Optical Fiber is Delicate, Sensitive to Bending
- Industrial Robots Not Compact Enough to Access Space Between High Density Interconnects Without Destroying/Damaging Interconnects
- Must be Much More Reliable and Scalable Than Today's Optical Switches (i.e. MEMS)

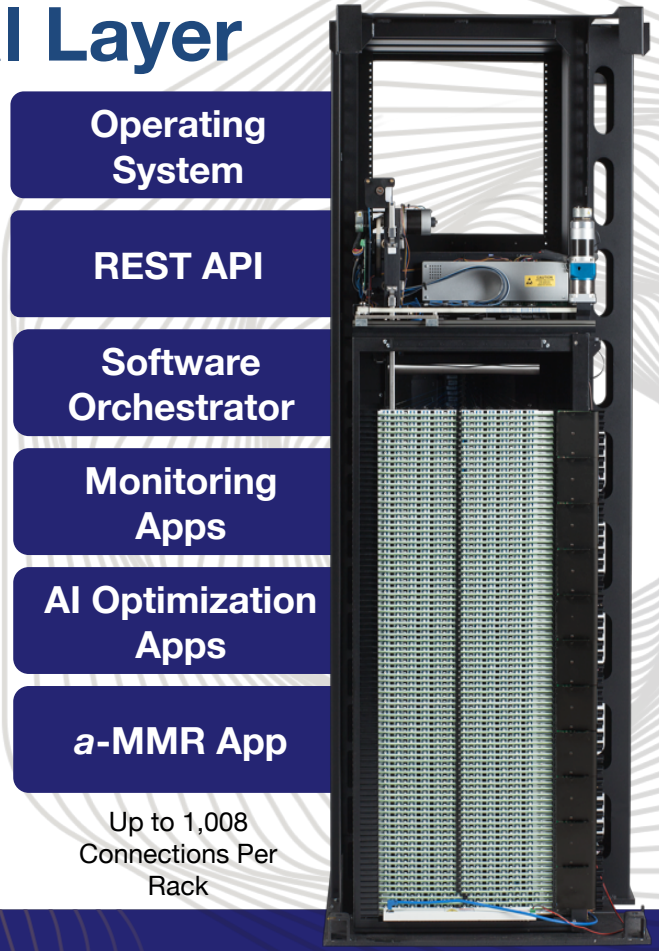
Telescent Network Topology Manager (NTM)

NTMs to Automate Data Centers:

- **Incorporates AI, Robotics and Network Performance Monitoring**
- **All-Fiber Design Provides Unsurpassable Performance**
- **Future-Proof**

Open API to Manage Physical Layer

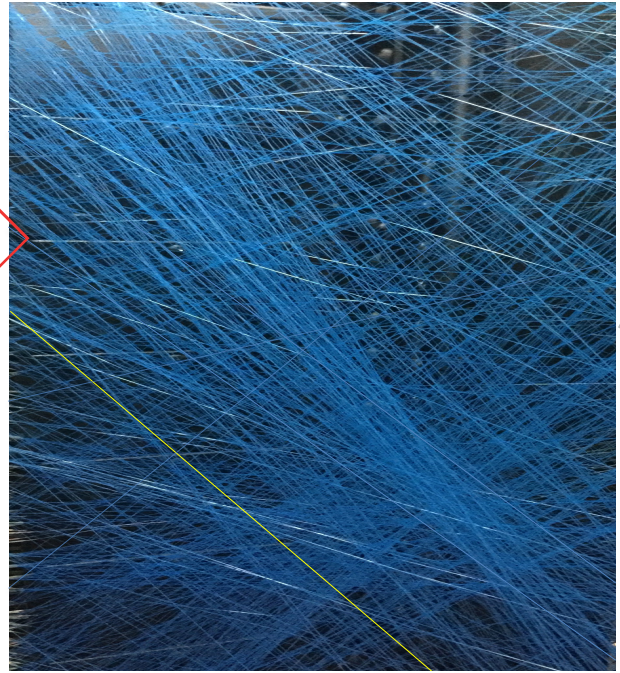
- **Automates**
  - Record Keeping
  - Troubleshooting
  - Network Performance and Security Monitoring
  - Reconfiguration of Interconnects
  - Security Checks and Balances
- **Accelerates**
  - Service Provisioning in Minutes vs Days
  - MTDC Billing Cycle
  - Service Restoration
  - Migration
  - DevOps/NetOps
- **Eliminates**
  - Emergency Calls at 2 am
  - Stranded CapEx: Servers, Line Cards, Spares
  - Dirty/Damaged Connectors
  - Human Error
  - Risk of Outage/Financial Penalties



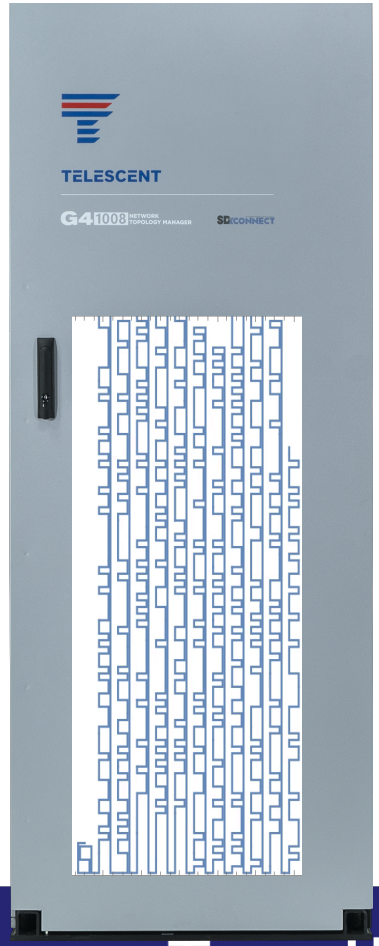
Up to 1,008 Connections Per Rack

Knots, Braids, Strands Algorithm

Dynamic Interconnect Fabric Transforms Between Arbitrary Connection States Without Entanglement



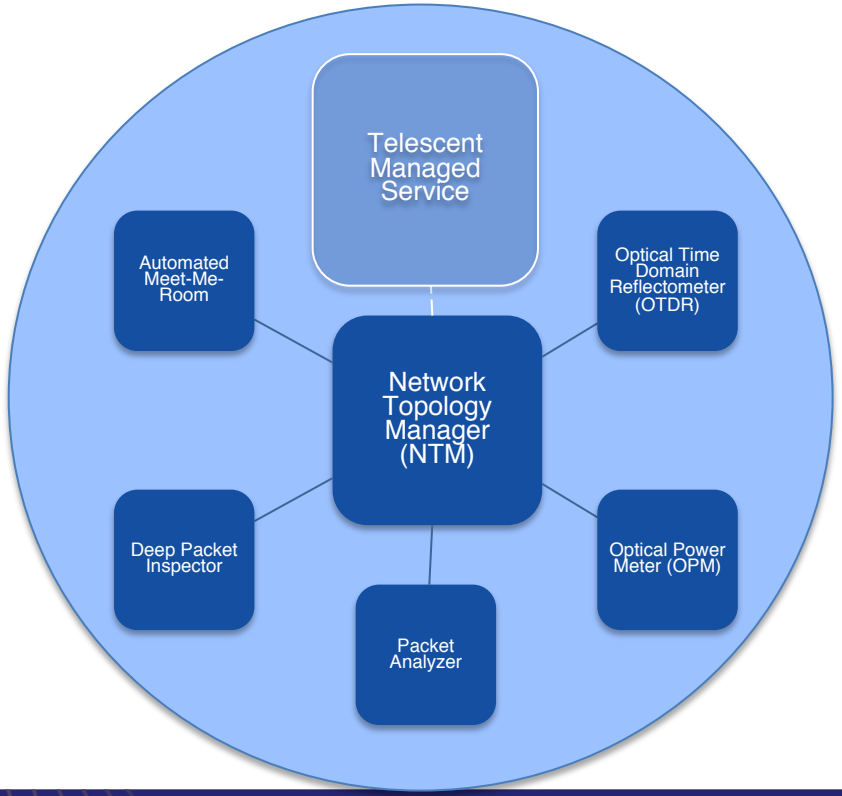
Internal Strands Routed Without Entanglement



- **Optical Fibers = “Strands”**
- **Set of Cross-Connects = “Braid”**
- **Blocking = “Knots”**

Open APIs Enable Physical Layer Health Monitoring and Analytics

- **NTM Dynamically Connects Optical Monitoring Probes**
  - Anytime, anywhere in network
  - Full visibility of physical network performance
  - Off-line and in-line monitoring
- **Probes Include:**
  - OTDR to monitor physical link integrity
  - OPM to monitor signal levels
  - Packet Analyzer to monitor Transport + Ethernet Deep Packet Inspector to monitor data packets and cybersecurity



Example Use Case
Automated Meet-me-Room (*a*-MMR)

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Long-Term Trend: Enterprises Outsourcing DCs, Moving Applications to Cloud

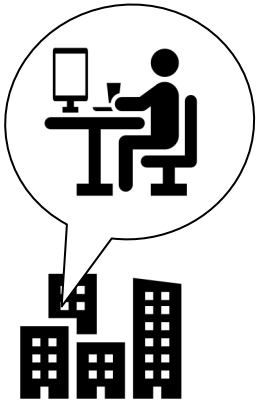
- For Security and/or Control, Enterprises Insist on Owning Equipment
- Don’t Want to Own and Operate Building Infrastructure
- MTDCs Allow Enterprises to Put Their Equipment in Shared Facilities, But in Secured Areas For Exclusive Access
- Enterprises Still Need to Connect to Carrier Transmission Facilities and Cloud Service Providers
- Connections Drive All-Important Meet-Me-Room “MMR” Service
- Equinix Forecasts 48% CAGR of Their MMR Interconnect Bandwidth Through 2024

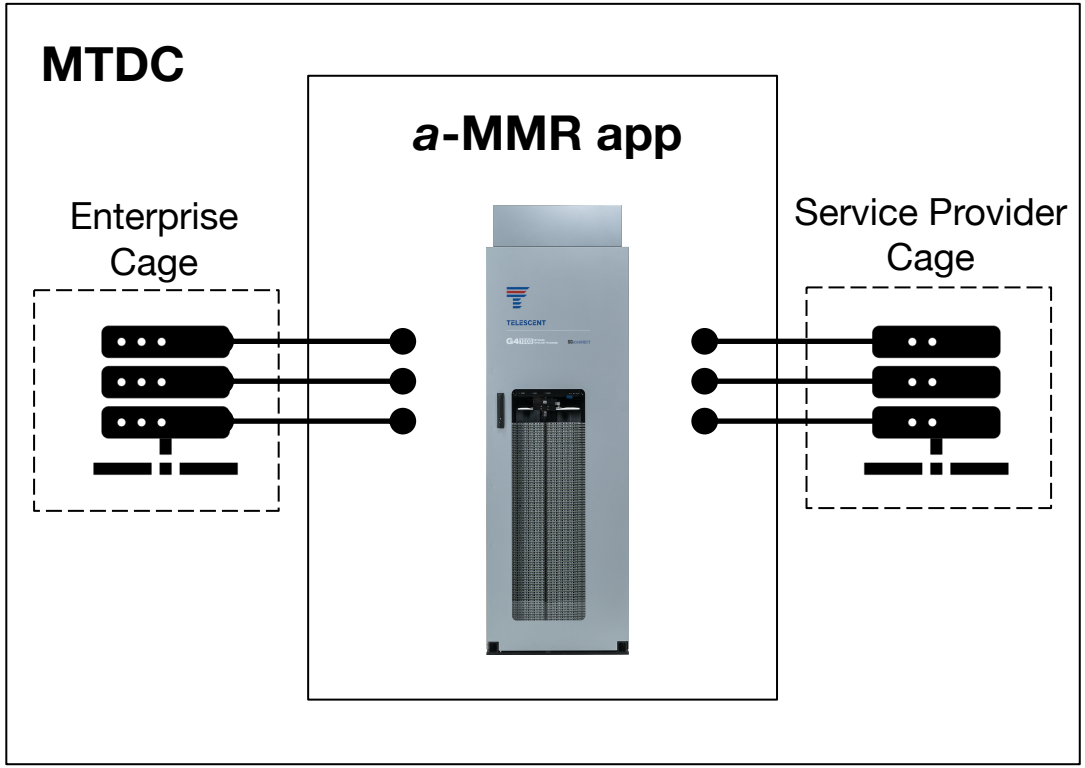
Definitions

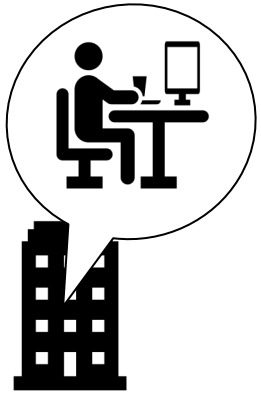
***a*-MMR = Automated Meet-Me-Room**
INTER-Cage = Connections Between Cages
INTRA-Cage = Connections Within Cage

Telescent *a*-MMR Service

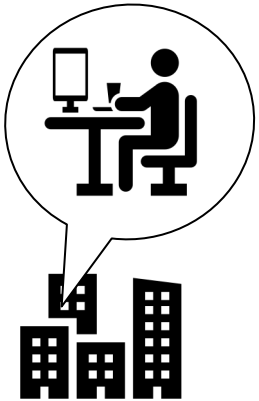
(1) Enterprise Requests Connection

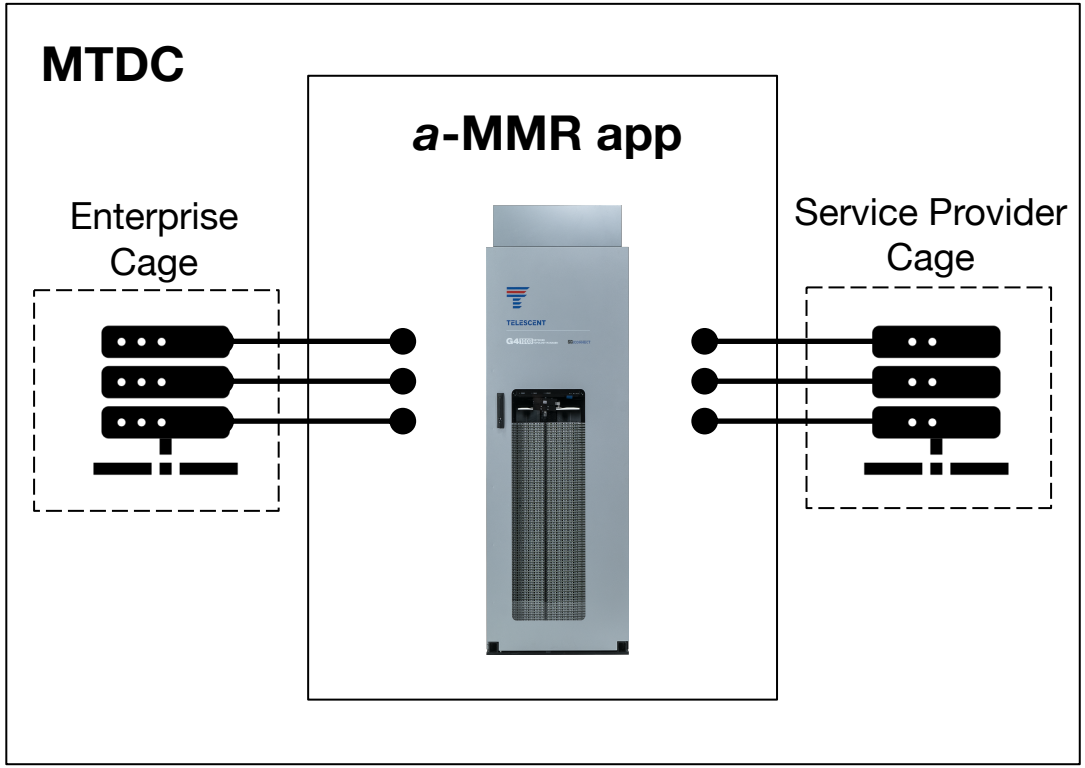




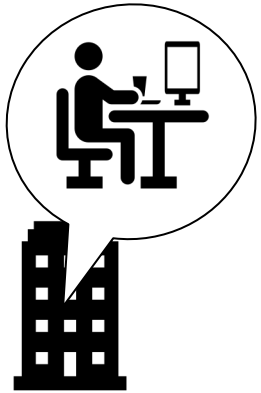


Telescent *a*-MMR Service

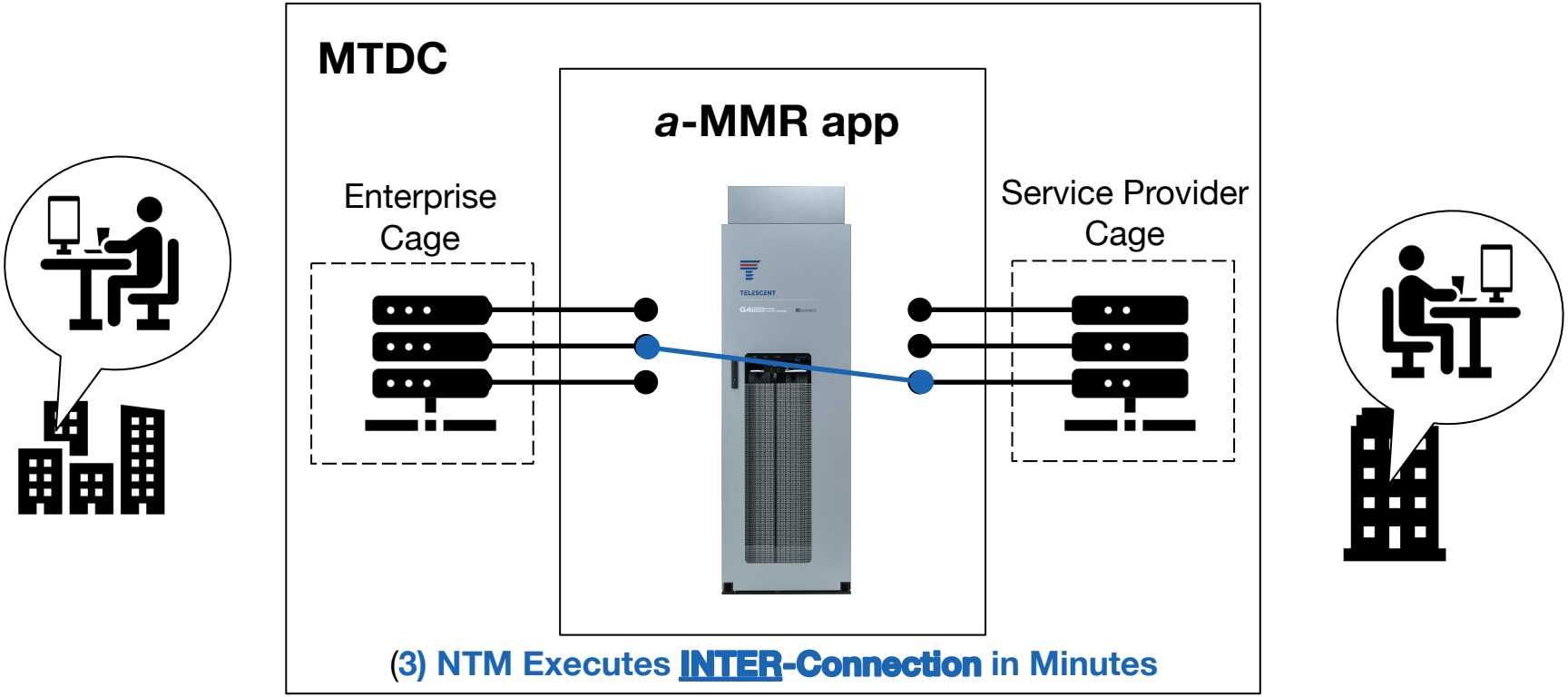




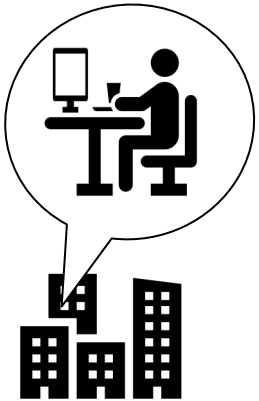
(2) Service Provider Accepts Connection Request

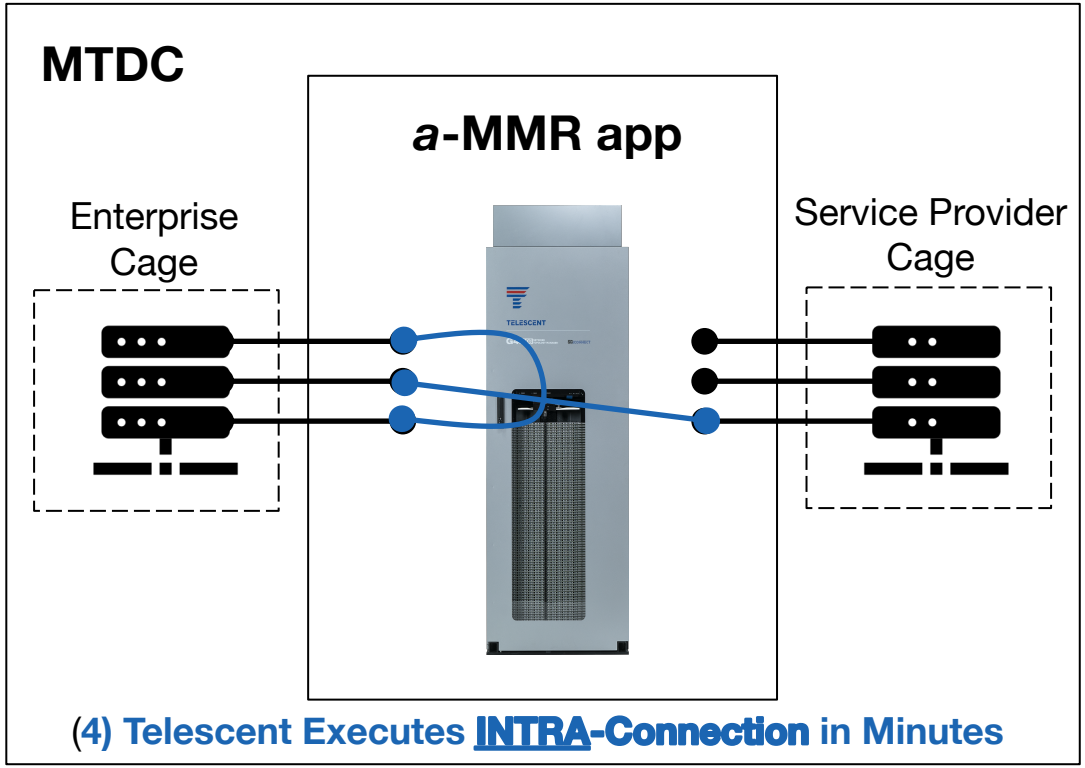


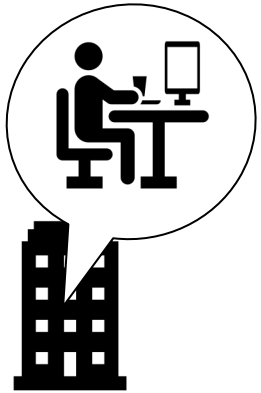
Telescent *a*-MMR Service



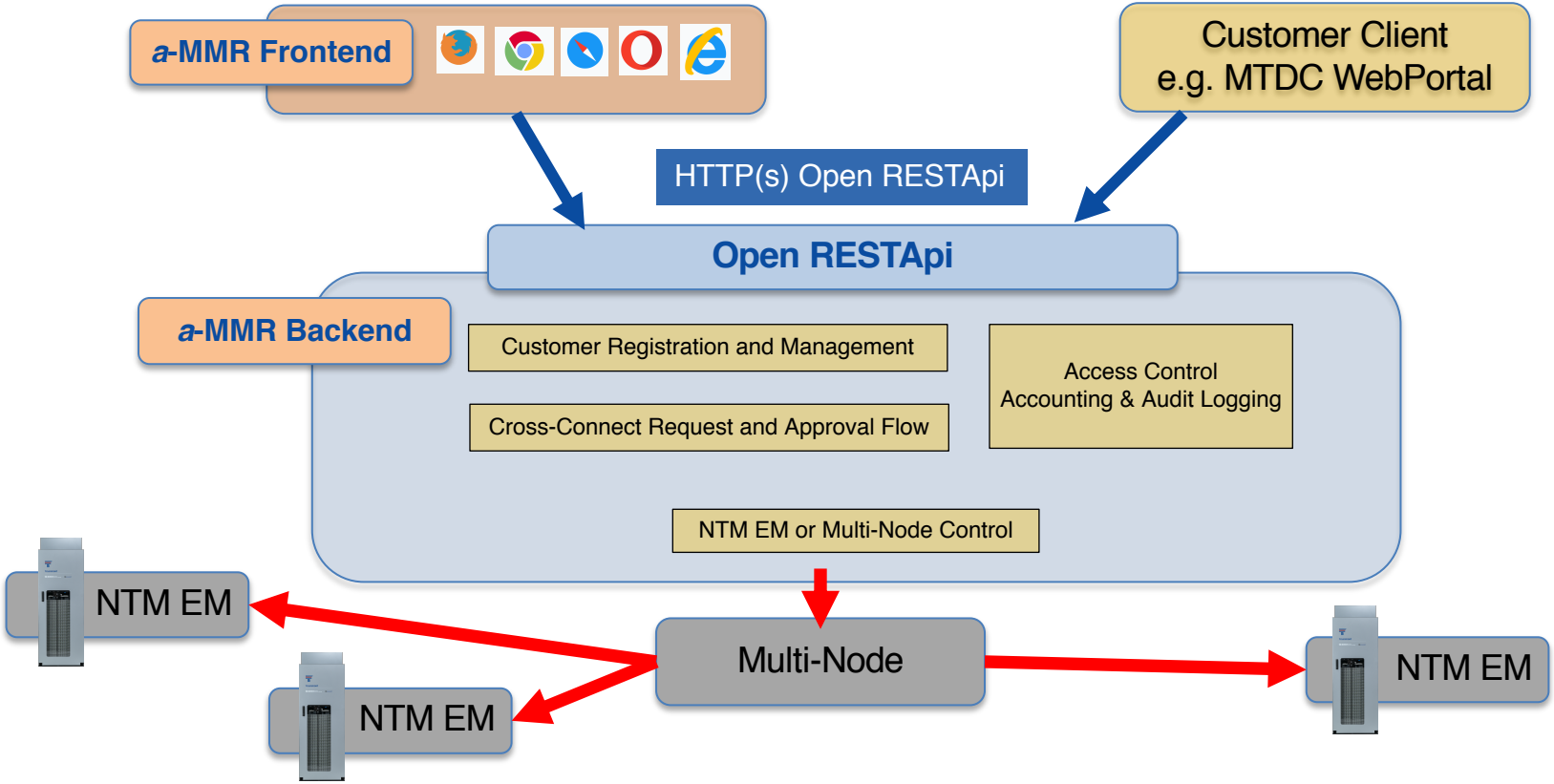
Telescent *a*-MMR Service







a-MMR App Software Architecture



Why Automation of MMR Will Become Ubiquitous

Initial Value Proposition is Faster MTDC Service Delivery, Increased Revenue Generation and Reduced OpEx

Improves MTDC Customer Satisfaction, Reputation and Competitiveness

Reputation Will Enable MTDCs to Lease-out More Cages, Increase Market Share and Grow Highly Profitable Interconnect Business

Ultimately, ALL MTDCs Will Need to Automate to Remain Competitive

Additional Data Center Use Cases

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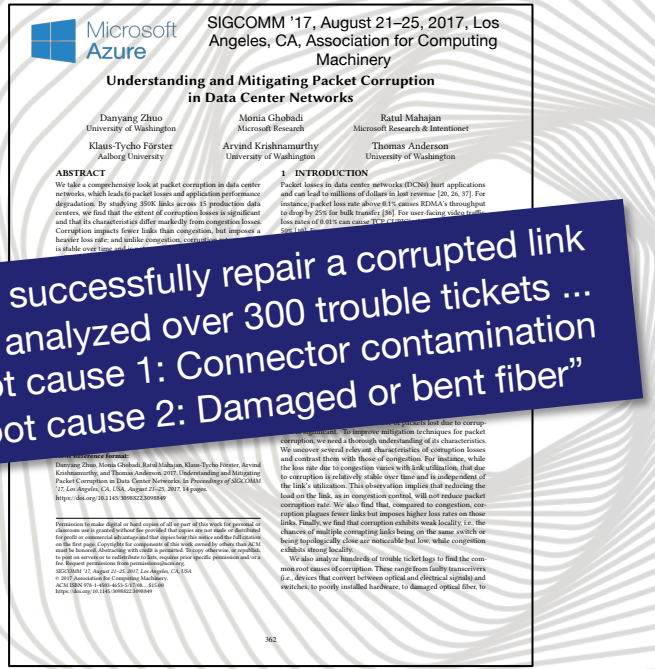
Fiber Plant Affects Data Center Performance

- **MSFT: Manual Processes Degrade Compute Efficiency Across Azure Cloud**
- **NTM Automates Connector Cleaning and Fiber Routing**
- **NTM Enables Automated Maintenance, Performance/Health Monitoring and Optimization**



Microsoft Azure

SIGCOMM '17, August 21–25, 2017, Los Angeles, CA, Association for Computing Machinery

Understanding and Mitigating Packet Corruption in Data Center Networks

Danyang Zhuo, University of Washington
Monia Ghobadi, Microsoft Research
Ratul Mahajan, Microsoft Research & Intentionet
Klaus-Tycho Förster, Aalborg University
Arvind Krishnamurthy, University of Washington
Thomas Anderson, University of Washington

ABSTRACT

We take a comprehensive look at packet corruption in data center networks, which leads to packet losses and application performance degradation. By studying 350K links across 15 production data centers, we find that the extent of corruption losses is significant and that its characteristics differ markedly from congestion losses. Corruption impacts fewer links than congestion, but imposes a heavier loss rate, and unlike congestion, corruption

1 INTRODUCTION

Packet losses in data center networks (DCNs) hurt applications and can lead to millions of dollars in lost revenue [20, 26, 37]. For instance, packet loss rate above 0.1% causes RDMA's throughput to drop by 25% for bulk transfers [36]. For user-facing video traffic, loss rates of 0.01% can cause [illegible]

"To successfully repair a corrupted link we analyzed over 300 trouble tickets … root cause 1: Connector contamination root cause 2: Damaged or bent fiber"

[illegible] to improve mitigation techniques for packet corruption, we need a thorough understanding of its characteristics. We uncover several relevant characteristics of corruption losses and contrast them with those of congestion. For instance, while the loss rate due to congestion varies with link utilization, that due to corruption is relatively stable over time and is independent of the link's utilization. This observation implies that reducing the load on the link, as in congestion control, will not reduce packet corruption rate. We also find that, compared to congestion, corruption plagues fewer links but imposes higher loss rates on those links. Finally, we find that corruption exhibits weak locality, i.e., the chances of multiple corrupting links being on the same switch or being topologically close are somewhat but low, while congestion exhibits strong locality.

We also analyze hundreds of trouble ticket logs to find the common root causes of corruption. These range from faulty transceivers (i.e., devices that convert between optical and electrical signals) and switches, to poorly installed hardware, to damaged optical fiber, to

Reference format:
Danyang Zhuo, Monia Ghobadi, Ratul Mahajan, Klaus-Tycho Förster, Arvind Krishnamurthy, and Thomas Anderson. 2017. Understanding and Mitigating Packet Corruption in Data Center Networks. In *Proceedings of SIGCOMM '17, Los Angeles, CA, USA, August 21-25, 2017,* 14 pages.
https://doi.org/10.1145/3098822.3098849

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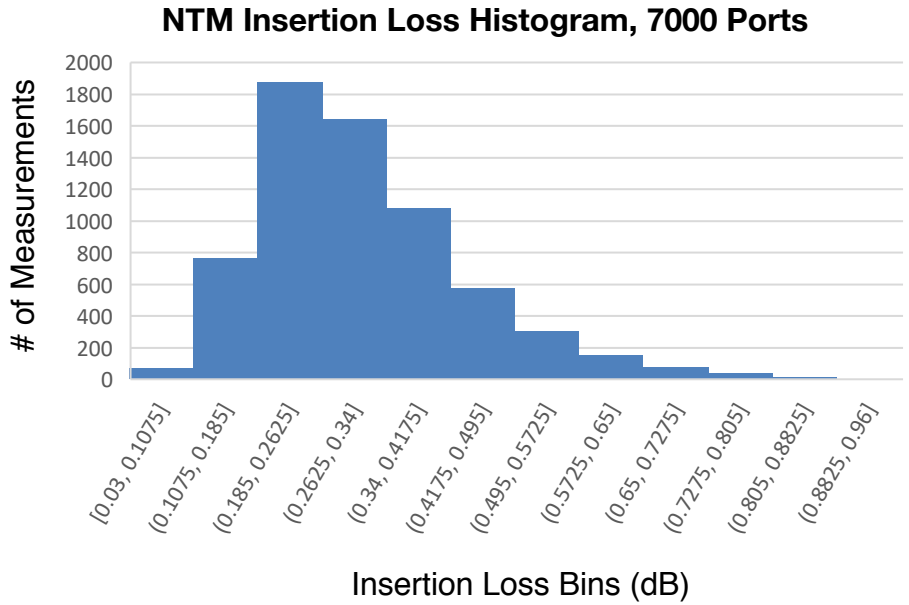
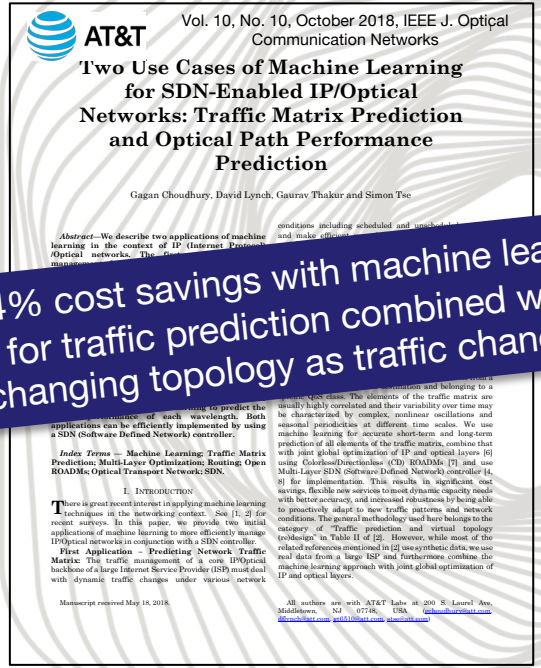
Automation of Fiber Plant Enables Use of Next Generation High Speed Pluggables

- **Next Generation Pluggables Have Lower Power/Lower Link Loss Budget**
- **Inherent Low Loss of NTM Connections Maintains Link Loss Less Than Budget**



Automation Improves Network Utilization

- **AT&T: Manual Processes Prevent Optimal Utilization of Network Backbone and Spares**
- **NTM Enables Distributed Performance Monitoring, Sharing of Spares and Load Balancing**



AT&T

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Two Use Cases of Machine Learning for SDN-Enabled IP/Optical Networks: Traffic Matrix Prediction and Optical Path Performance Prediction

Gagan Choudhury, David Lynch, Gaurav Thakur and Simon Tse

"34% cost savings with machine learning for traffic prediction combined with changing topology as traffic changes"

Conclusion

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