TRELLIS
AN ANALYTICS FRAMEWORK FOR UNDERSTANDING SLINGSHOT PERFORMANCE

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MOTIVATION

- Application Performance can be sensitive to Network
  - Topology
  - Routing and Congestion Control
- Slingshot
  - Adaptive Routing
  - Advanced Congestion Control
- Problem: “What is happening in the network?”
- Solution: Monitor the HPC Interconnect
  - At the global fabric level
  - At the application level
INTRODUCTION: TRELLIS

• Analytics Framework to Observe and Understand Network Performance
  • Initial target - Slingshot

• With trellis, you can
  • Infer topology and layout
  • Get telemetry as timeseries dataframe
  • Get aggregated, thresholded telemetry
  • Map Job Characteristics to Topology/Telemetry

• Build customized, targeted workflows
• Design UIs for a broader use-case
INTRODUCTION: WHY TRELLIS?

~160,000 metrics @1Hz (1024-node Cray EX System)

Raw Telemetry

Actionable Insight

Application Performance

Exploring New Monitoring and Analysis Capabilities on Cray's Software Preview System. Jim Brandt et al., 2019
INTRODUCTION: WHY TRELLIS?

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Application Performance
EXAMPLE: MONITORING AT THE APPLICATION LEVEL

- **Goal**
  - Use trellis with an instrumented application
  - Recognize communication patterns

- **Application**
  - GPCNET (128 PPN)
  - Pair-wise all-to-all and Incast pattern

- **System:** “Shandy” (version 1.3)
  - 1024 Node, dual-socket, EPYC Rome
  - Network Topology
    - 8 Groups, 16 Switches per Group
    - 128 Nodes per Group
    - Dual Mellanox ConnectX-5 NICs per Node
EXAMPLE: VISUALIZATIONS

Edge Port connected to compute node

- **allocation**: ports used by GPCNET
- **mpi**: avg. MPI latencies in GPCNet
- **rxBW**: avg. bandwidth received (MBps)
- **txBW**: avg. bandwidth transmitted (MBps)
- **rxBlocked**: avg. frames blocked (per second)
DIVING INTO SLINGSHOT BEHAVIOR WITH TRELLIS

Slingshot Analytics

Performance Metrics
rxBW

Submit
Enter

Overview

Group View

Switch View

Average rxBW with time

Time

port_type
edge
local
global
EXAMPLE: MONITORING THE NETWORK FABRIC

Network Overview - Fabric Health and Link Failures

Overlay Jobs and Network Performance
No aggregate telemetry data...
TRELLIS: IMPLEMENTATION

- Fast, User-friendly Pythonic APIs
- Fuse multiple data sources
- Transformations on Telemetry
API QUICK TOUR

Topology Queries

Topology queries let you get connectivity information at the fabric, group and switch level, as an adjacency list in a pandas dataframe.

Get the topology for the entire fabric

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<td>x1000c8r3j17p0</td>
<td>58.0</td>
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</table>

Get all compute nodes connected to switch "x1000c5r1b0"

<table>
<thead>
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API QUICK TOUR

Aggregate telemetry

Get an aggregated telemetry for the entire fabric. Telemetry can be aggregated by using one of \([\text{max, min, mean, sum}]\), for a given time period, and a metric (i.e. \text{rxBW, txBW, rxBlocked}).

```python
# get the average rx Bandwidth across the fabric
# for a time-interval
df = trellis_telemetry_api.get_agg_telemetry(
    datetime_range = [
        pd.Timestamp("2021-01-23 00:30:00"),
        pd.Timestamp("2021-01-23 01:15:00")
    ],
    agg_type='mean',
    counter_name='rxBW'
)

df.head()
```

CPU times: user 47.8 ms, sys: 3.2 ms, total: 51 ms
Wall time: 2.61 s
CLOSING REMARKS

• Problem: “What is happening in the network?”

• Foundation: Monitoring Application/Network Performance with trellis
  • Identify communication patterns
  • User-friendly UI for Network Performance Overview

• Pythonic APIs
  • Powerful and Efficient
  • Enable custom workflows

• Paper: Additional examples with
  • Job-mixes
  • Communication Patterns
FUTURE WORK

• Scaling Considerations
  • Goal: Interactivity while maintaining accuracy
  • Today: 1024-node System, 4-hour telemetry
    – 0.5 billion data-points
  • Trade-offs: Resolution of
    – Data acquisition
    – Analysis
    – Visualization

• Modeling Performance
  • Modeling sensitivity of applications to network performance
  • Optimizing job-mixes

• Looking forward to some exciting collaborations!
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