IMAGINE THE POSSIBILITIES...
Using Machine Learning to Automate Node Split Design and HFC Augmentation Options

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IMMCO, Inc.
Using Machine Learning to Automate Node Split and HFC Augmentation Options

Agenda

- Key Network Datapoints – United States HFC Networks
- Overview of Artificial Intelligence (AI) and Machine Learning (ML)
- HFC Network Capacity Augmentation Methods
- Implementing Machine Learning for Node Split Design
- Machine Learning Node Split Design Example
- Creating a Holistic Network Capacity Augmentation Environment enabled by Machine Learning
- Conclusion
United States HFC Network Statistics

- >300,000 Nodes
- >700,000 Power Supplies
- ~2,000,000 HFC Plant Miles
- >70,000,000 US MSO Internet Customers
- >40% CAGR Broadband Consumption
- Streaming Video, Game Streaming, AR/VR
- COVID-19 induced telework and virtual classrooms driving increased data use.
Artificial Intelligence (AI) and Machine Learning (ML)

Artificial Intelligence – computer systems developed to perform tasks humans typically do better:
- Robotic Welder
- Recommendations from online retailer or video streaming service.
- Real-time traffic-monitored route planning – e.g. GoogleMaps/Waze

Machine Learning – builds on AI by enabling computer systems to measure performance and improve outputs
- Robotic welder with x-ray scanner to monitor and improve weld quality
- Photoscanning to identify friends in social media posts
- Voice-to-text and language translation
Inside Plant Options:
• Activate unused or repurpose EIA’s
• Service Group de-combine/re-combine
• Increase modulation density (64-256 QAM, OFDM)

Outside Plant Options:
• Extend fiber to heavy-use households to de-stress DOCSIS platform
• Node Splits:
  • Add transceivers (segmentation)
  • Add new node, minimum construction, no HHP balancing
  • Add new node, design for HHP balance and future segmentation
  • Add new node, design for peak data utilization balance and future segmentation
  • Add Remote PHY – MAC/PHY device

Implementation Challenges:
• Municipal Permitting
• Maintenance Window Availability
• Underground more expensive and disruptive than aerial

Extensive Planning and Analysis with constant adjustments is required
Implementing Machine Learning for Node Split Design

Determine the Programming Environment

Which Programming Language?
- Python
- Java
- C++
- C#
- R
- JavaScript
- Scala

Which IDE (Integrated Development Environment)?
- PyCharm
- Rstudio
- R-Brain
- Jupyter
- Spyder
- Geany
Learning Process

- **Supervised**: data is labeled, and the ML system is taught by example
  - Pictures labeled as “banana” or “hammer” for system to learn

- **Unsupervised**: data is clustered and ML environment looks for anomalies
  - Financial fraud detection from analyzing normal spending habits

Decision Tree / Classification Engine

- GBM – Gradient Boosting Machine
- Random Forests
- Logistic Regression
## Network Data Extract

### Node under design must be extracted from map system

Each element assigned unique ID

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<th>Equipment</th>
<th>Element ID</th>
<th>DS HHP</th>
<th>Leg Balancing DS</th>
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Business Rule Development

• Can the Node be segmented?
• Is the proposed location geographically centered in the node polygon?
• Are Homes Passed Balanced?
• Is cascade limit exceeded?
• Is there space on the pole or in the ped for the Node?
• Does RF signal meet specifications?
• Does node activity meet minimal construction parameters if desired?
• Is any coax reversing required?
• Is fiber splice location reachable?
Machine Learning Node Split Example

Machine Learning Network Element Relational Schematic
Proposed Location — minimum construction, no HHP balancing chosen

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<tr>
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<th>HHP</th>
<th>Ratio</th>
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<td>Original Node</td>
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<td>Original Node after split</td>
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<td>New Node after split</td>
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ML-designed Node Split with balanced HHP

Designer time saved: 30 minutes per node split!

<table>
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<tr>
<th></th>
<th>Original Node Leg A</th>
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<td>26%</td>
<td>34%</td>
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Possible inputs for ML analysis, design, and what-if analysis

Creating a Holistic Network Capacity Augmentation Environment
Thank You!

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