Understanding the Context of Network Traffic Alerts

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Motivation
Networks are constantly under attack from malicious users. Attacks are hidden inside a massive amount of harmless traffic. Experts require tools to detect and correlate malicious messages in a sea of traffic.

Data: Wireshark log
- Fine grained
- Dense
- Attacks are hidden

Data attributes
1. Timestamp
2. Ip address
3. Mac address
4. Protocol
5. Protocol flags
6. Message size
7. Many more metadata attributes

Anatomy of an attack
- Localized to a time interval
- Composed of many messages
- Can span multiple machines
- Exhibit uncommon behaviour
- Example: Man in the middle
Malicious user intercepts, potentially modifies, and relays messages.

ML tools
Tools such as snort and Bro use ML to detect attacks.
1. Train on sample traffic
2. Monitor streaming traffic
3. Output outliers, and known attack patterns

Downsides
1. Lots of alerts
2. Large number of false positives
3. Difficult to query
4. No intuitive feedback

CoNTA - Contextual Analysis of Network Traffic Alerts
Interactive discovery and refinement of alerts.

Time Table grid view View
Y axis: Machines
X axis: Attributes
Display allows for the visual correlation of alerts which compose an attack.

Time Table example 3 separate mac addresses

Discovery: Conversation View
- Communication topology is useful for identifying malicious and colluding machines.
- Thickness of edges corresponds to bandwidth

Discovery: Heat map
- General aggregate information displayed as heatmap
- Useful for detecting high level trends
*Alerts per IP over time

Identification: Selection
Users select areas of interest
Selected data is highlighted in green
All visuals are updated with selected data

Identification (Attribute Histograms)
- Traffic is bucketed into histograms based on attributes.
- Left column shows the distribution of all traffic.
- Right column shows the distribution of alert traffic only

Interactive Identification
A data packets can have hundreds of attribute values, experts need to filter and search for information relevant to an attack.
- Manually set #of attribute buckets
- Sort histogram
  - Alphabetical
  - Most alerts
  - Relevance

Interactive Classification
IDS false positives are high, CoNTA uses 4 interactive training strategies:
1. Filtering
2. Projection
3. Binning
4. Self training
Confirmation (inspecting messages)
- Pixel map encodes individual messages
- Attributes are color coded
- Red outlines encode alert messages
- Upon selection raw message data is displayed

Context Preservation
- Selecting and zooming can cause a loss of context
- Iterative selections form a hierarchy
- The hierarchy is displayed as a tree
- Histogram display the coverage of the selection

Evaluation (use cases)
- Water Plant (synthetic)
  - Detected man in the middle attack
  - Used [Line chart, histograms, pixel map]
- University (real logs)
  - Detected a user remotely installing software
  - Used [heatmap, manual filtering, conversation topology]

Time for a demo video ??
link

What Why How
What
- messages and alerts from IDS
- Communication graph
Why
- Attack detection
- Correlation between malicious messages
How
- High level heat maps, and line charts to detect patterns
- Mouse selection, and queries to facet data
- Pixel map for inspecting individual packets

Limitations
- Histograms don’t scale well if the number of attributes are high
- Number of visible attributes is constrained by the number of histograms
- Requires an IDS that supports interactive learning

Critique
- Information about malicious packets are spread across many histograms perhaps clustering (tSNE) alerts on their attributes would help detect trends.
- Selections must be contiguous, making correlations between multiple features difficult.
- All visualizations are built for a 5 - 20 machine network, so they do not apply to data centers which desperately need them.
- Pixel packet view is not temporally aligned which could cause confusion.
- Color contrast (green on gray) has great pop out and is effective at maintaining context between views.

Conclusion
- CoNTA provides an interactive attack detection framework
- Helps experts translate high level phenomenon to packet attributes
- Has a very nice selection interface

Questions ???