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CleanBGP: Verifying the Consistency of BGP Data

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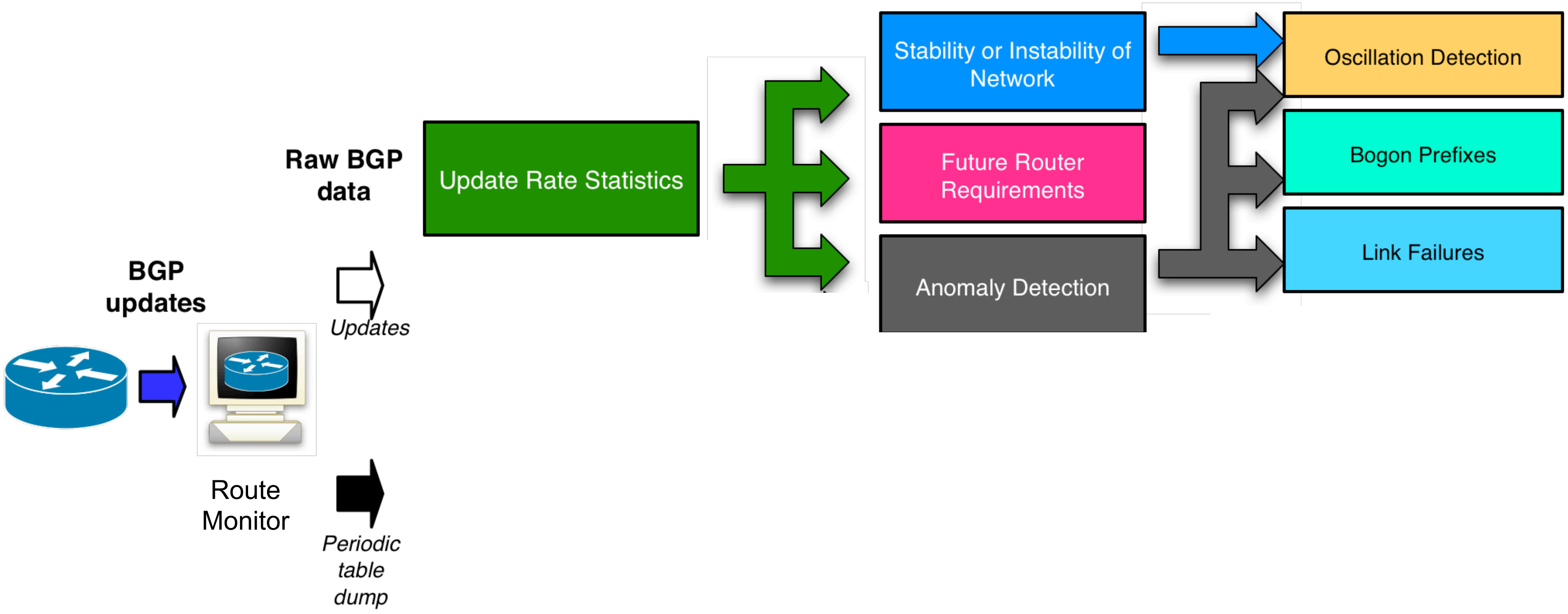
Why is BGP Data Important?



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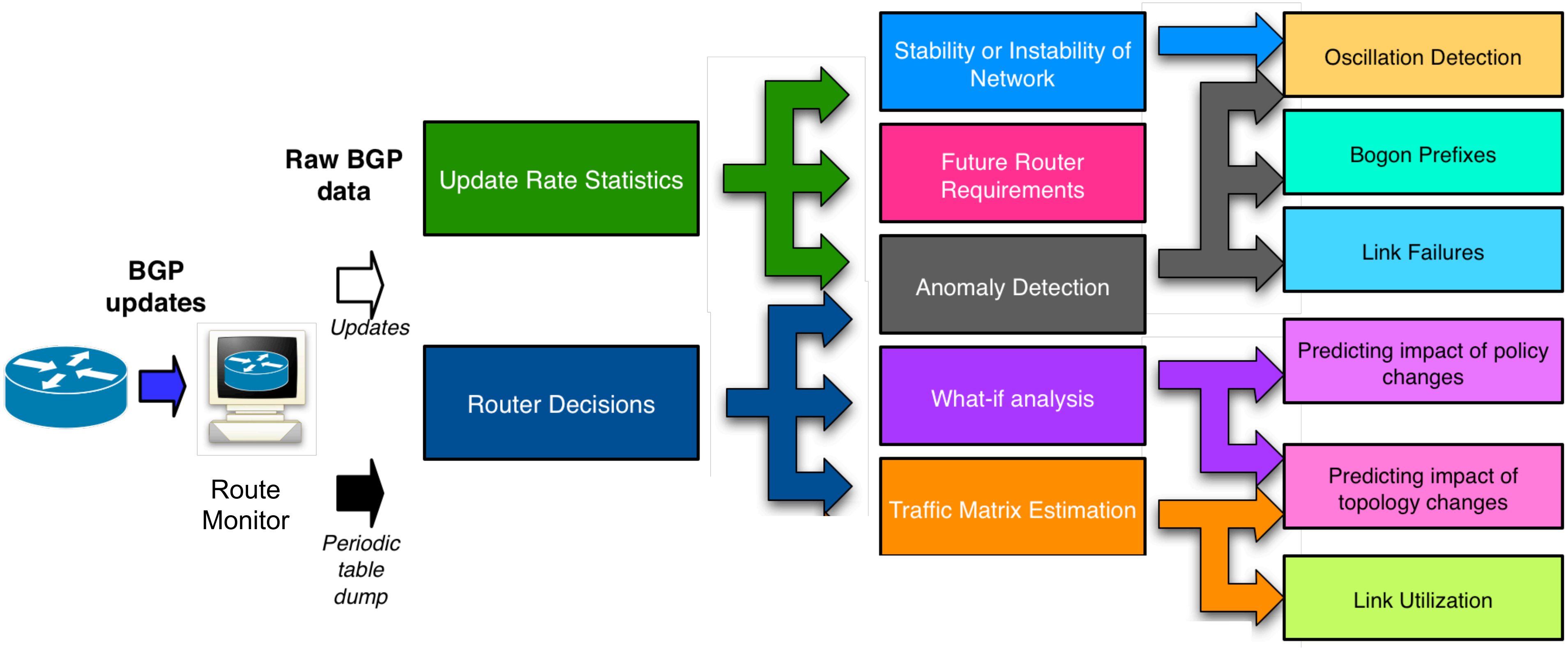

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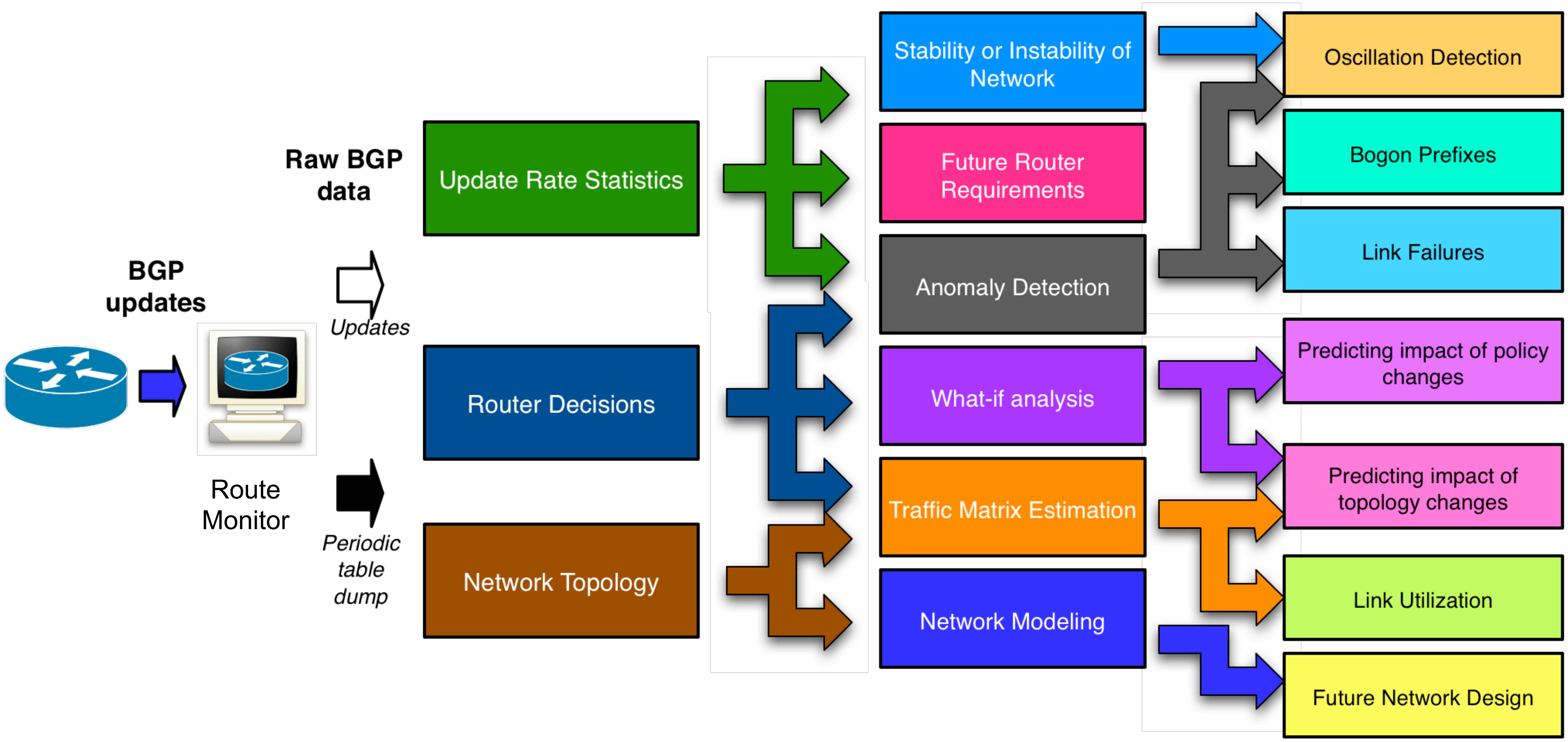
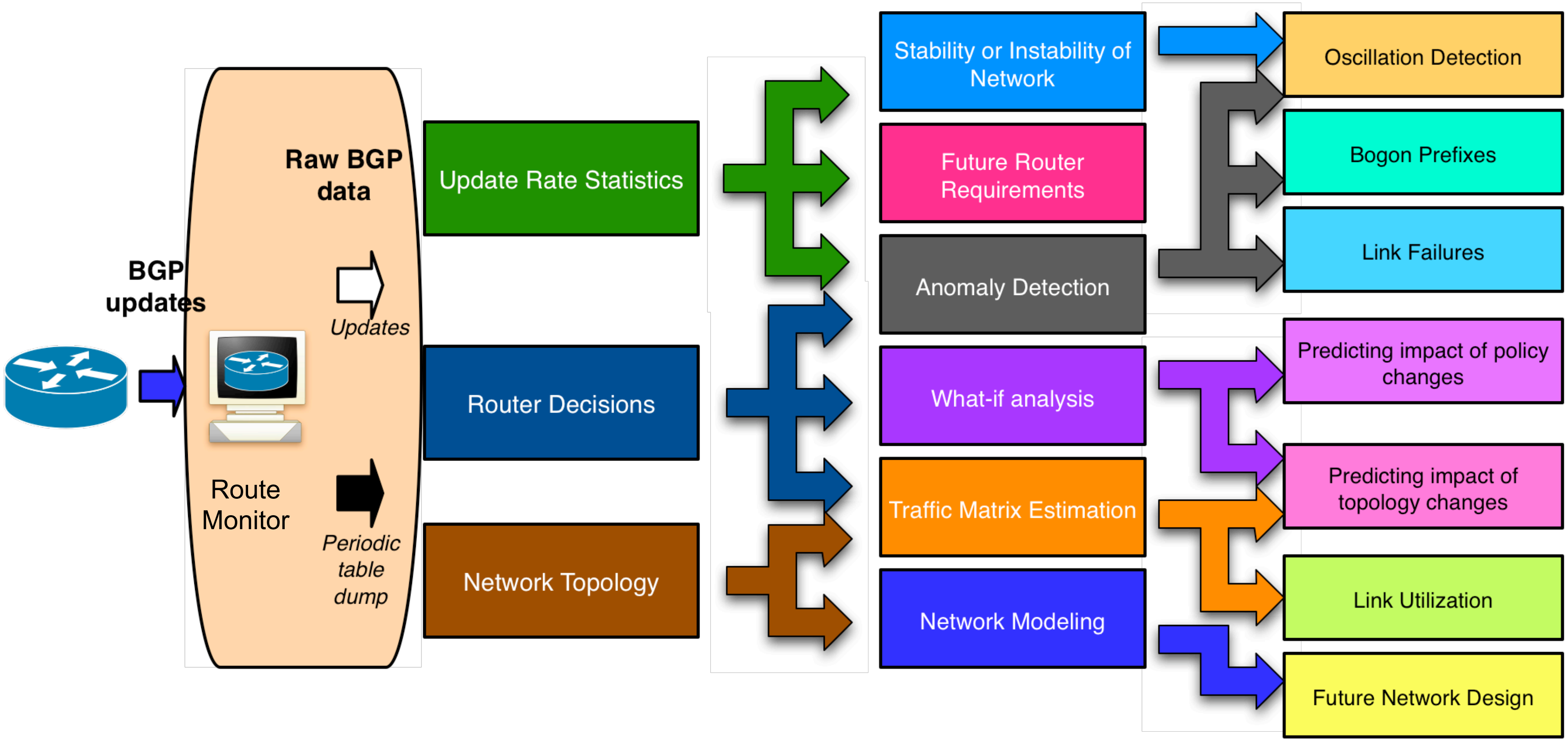
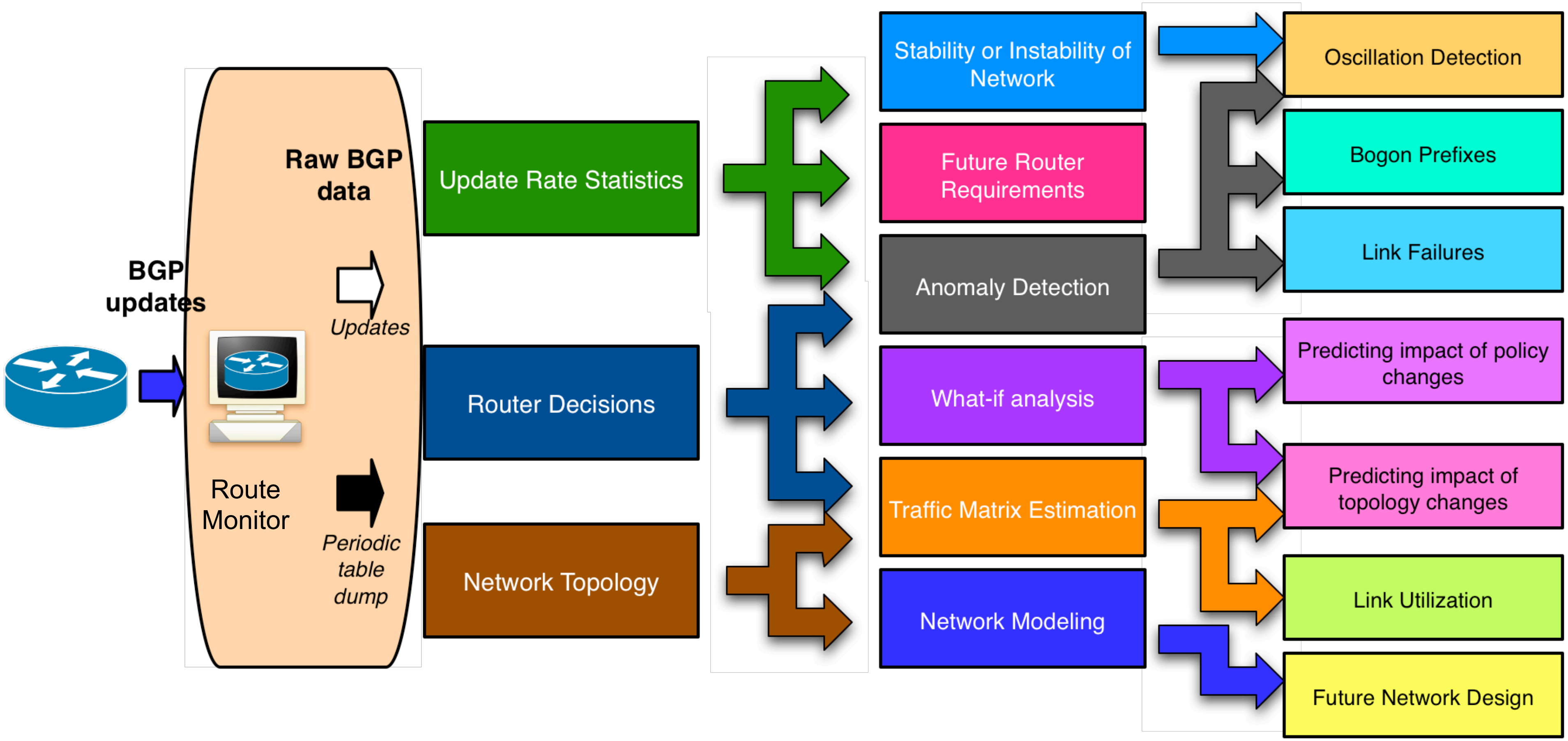


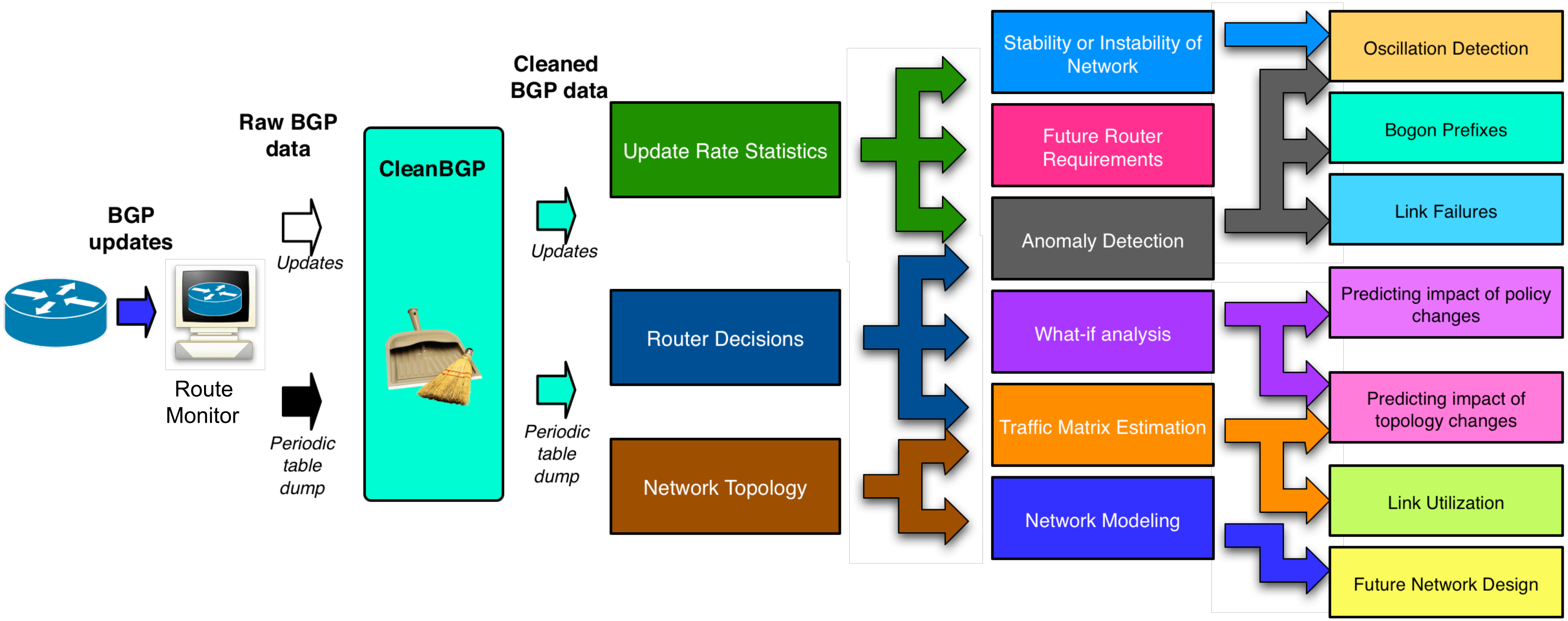
Why is Accurate BGP Data Important?



How Can We Check the Accuracy?



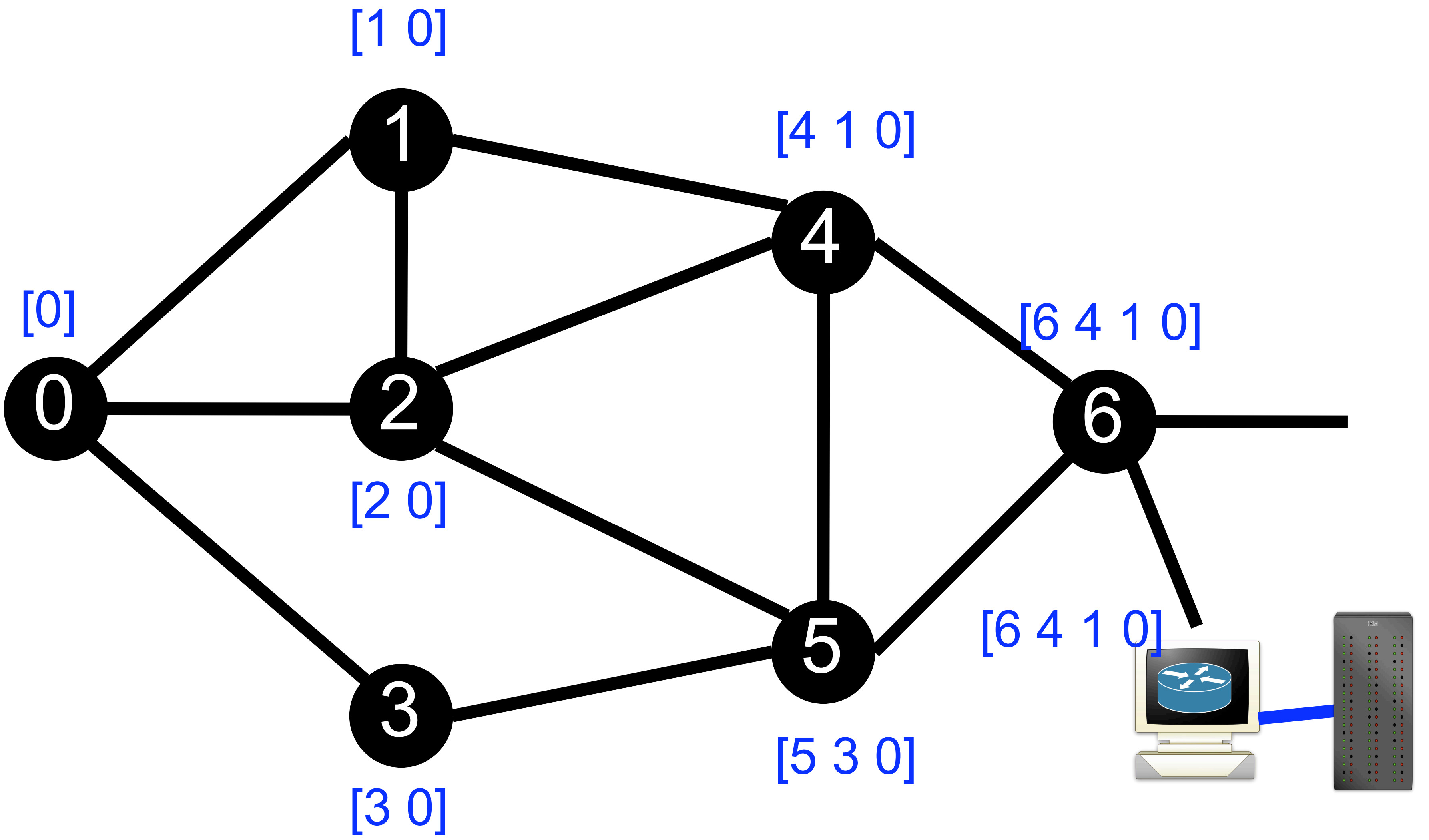
CleanBGP


BGP updates
Route Monitor
Raw BGP data
Updates
Periodic table dump
CleanBGP
Cleaned BGP data
Updates
Periodic table dump
Update Rate Statistics
Router Decisions
Network Topology
Stability or Instability of Network
Future Router Requirements
Anomaly Detection
What-if analysis
Traffic Matrix Estimation
Network Modeling
Oscillation Detection
Bogon Prefixes
Link Failures
Predicting impact of policy changes
Predicting impact of topology changes
Link Utilization
Future Network Design

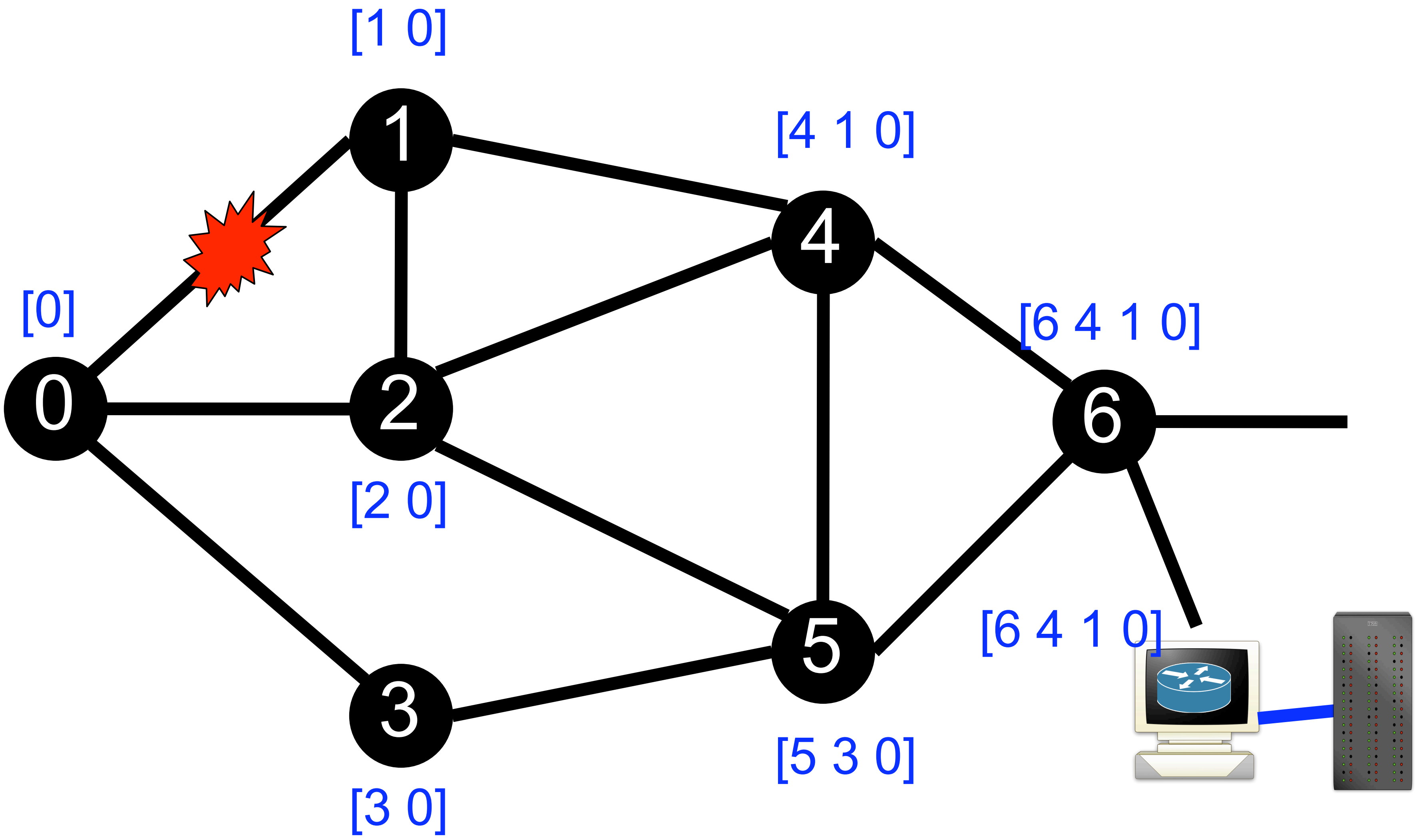
Data Sources

- Tables
  - Current route of monitored router to all possible destinations (prefixes)
  - Periodically written to disk
    - RIPE (8 hours)
    - RouteViews (2 hours)
- Updates
  - BGP is incremental protocol
    - No periodic retransmission of routes
    - Generally small fraction of routes in table updated in a short interval
      - Except when a BGP session is first being established

The Border Gateway Protocol



BGP Session Failures



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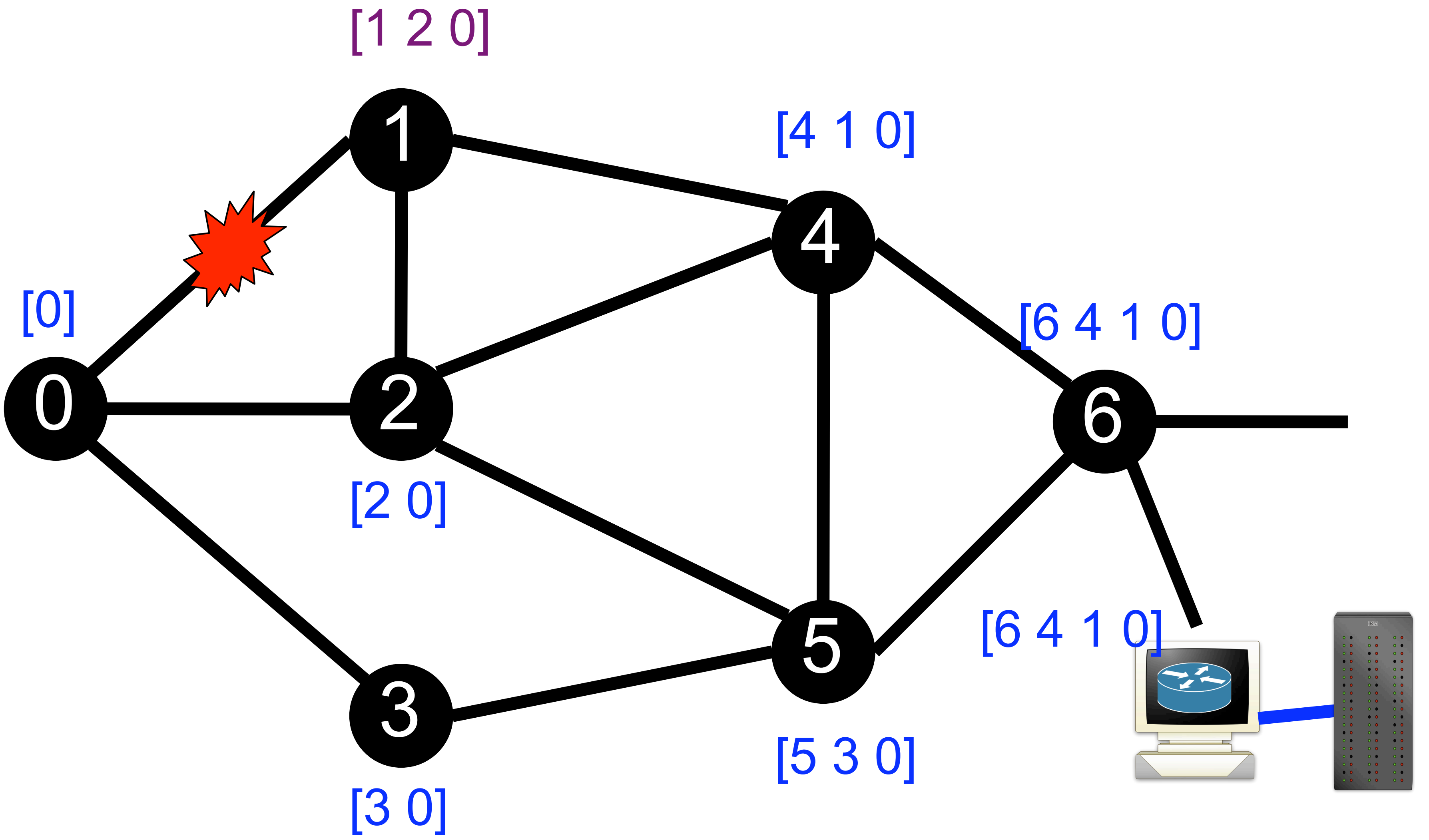

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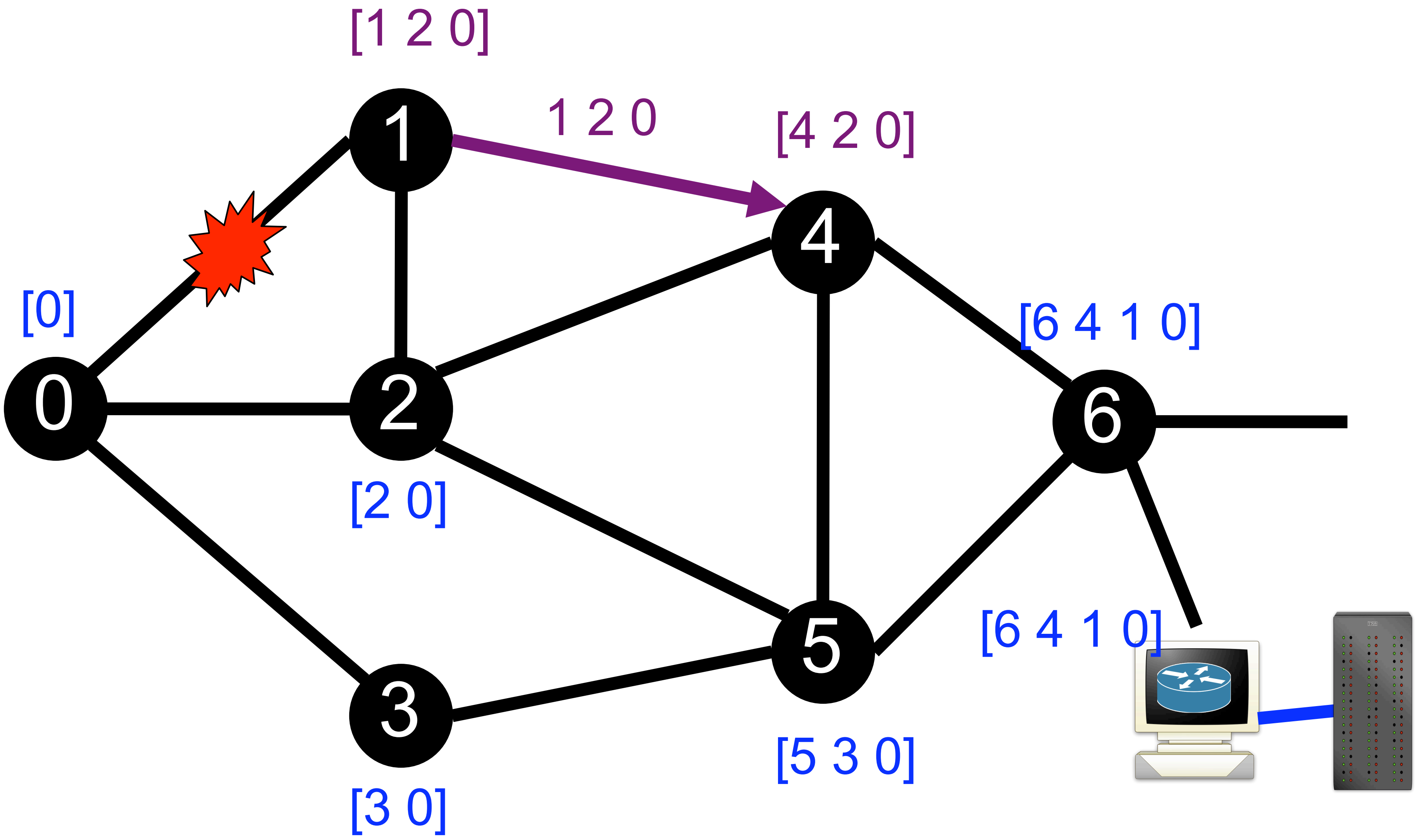

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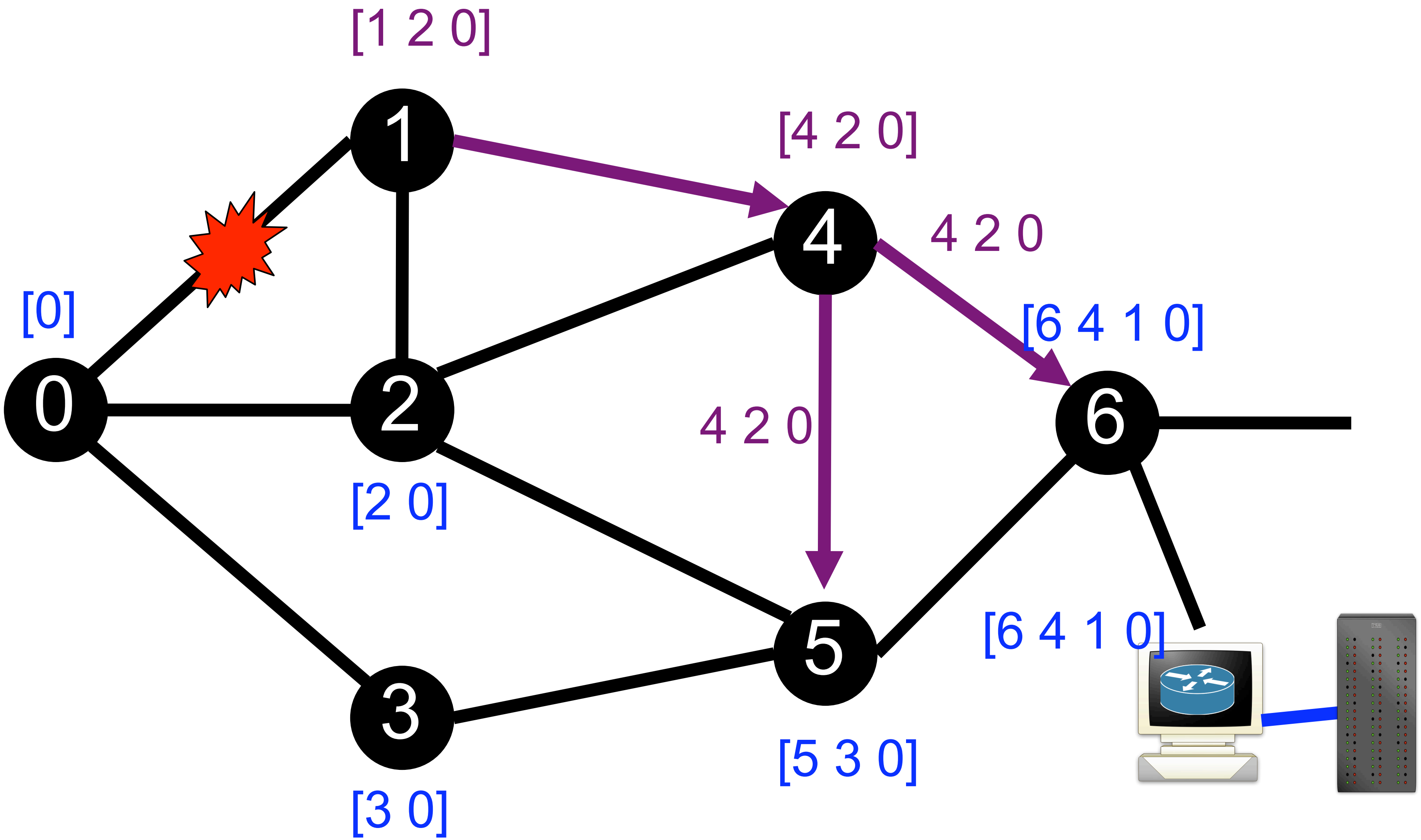

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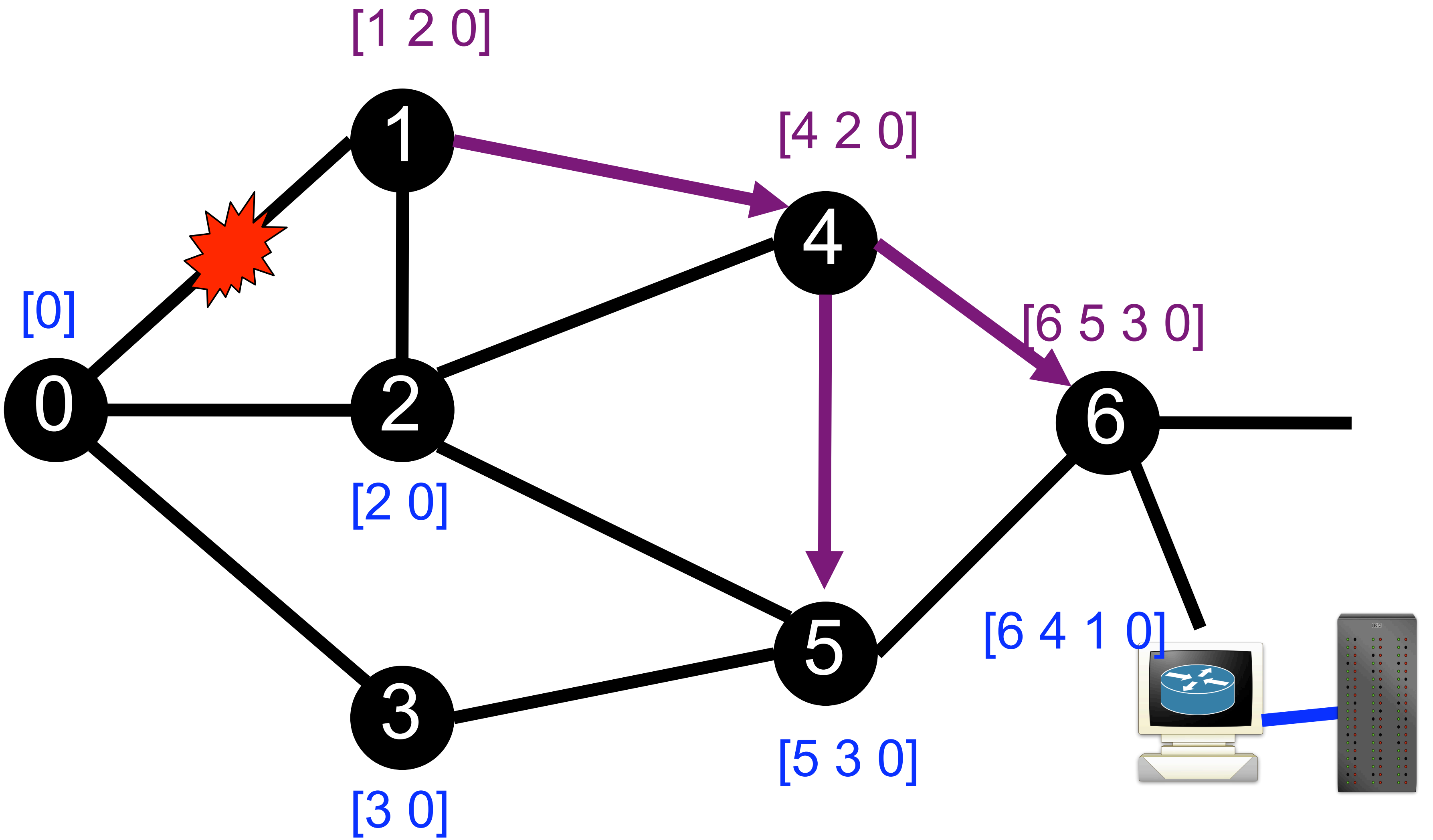

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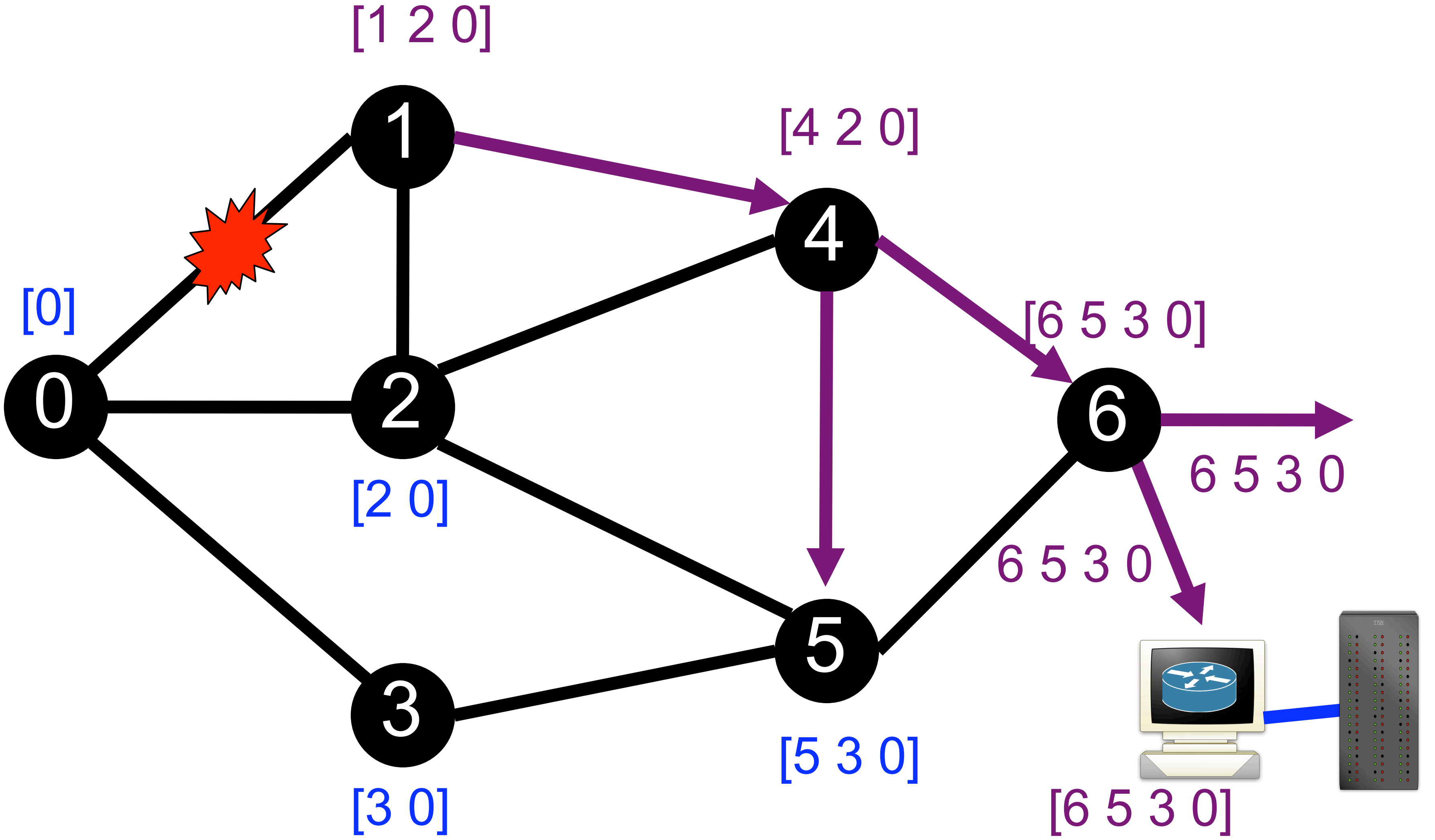
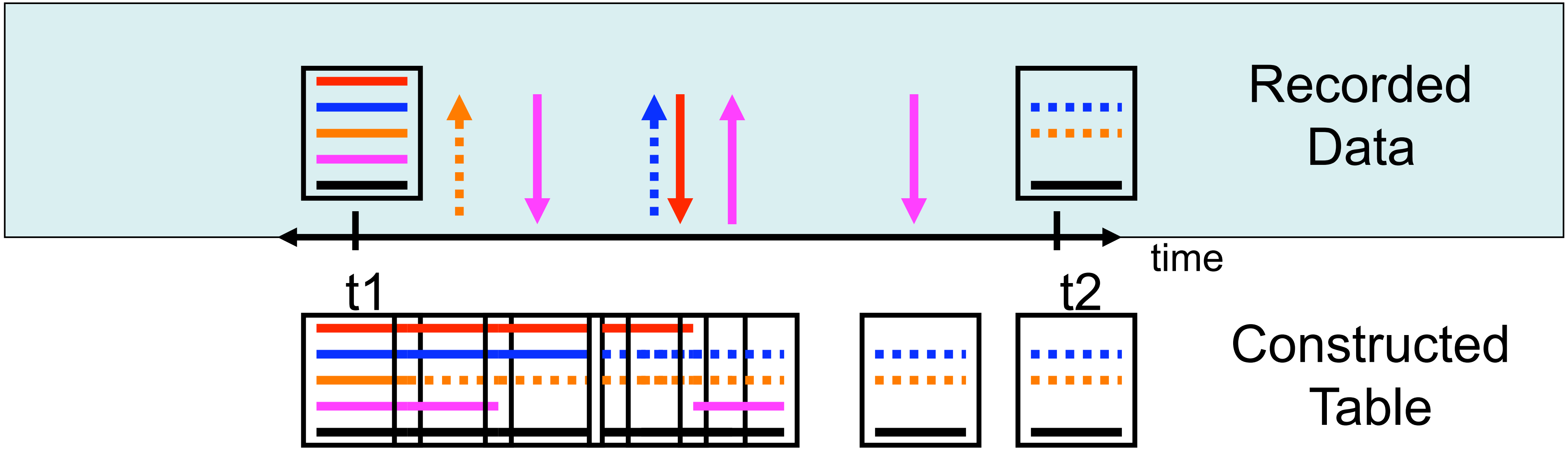


Data Consistency

- The BGP table is the construction of the last update for each prefix.
  - A table at t1 plus updates in the interval [t1,t2] is equivalent to the table at t2.
- In the recorded data this is not always the case!



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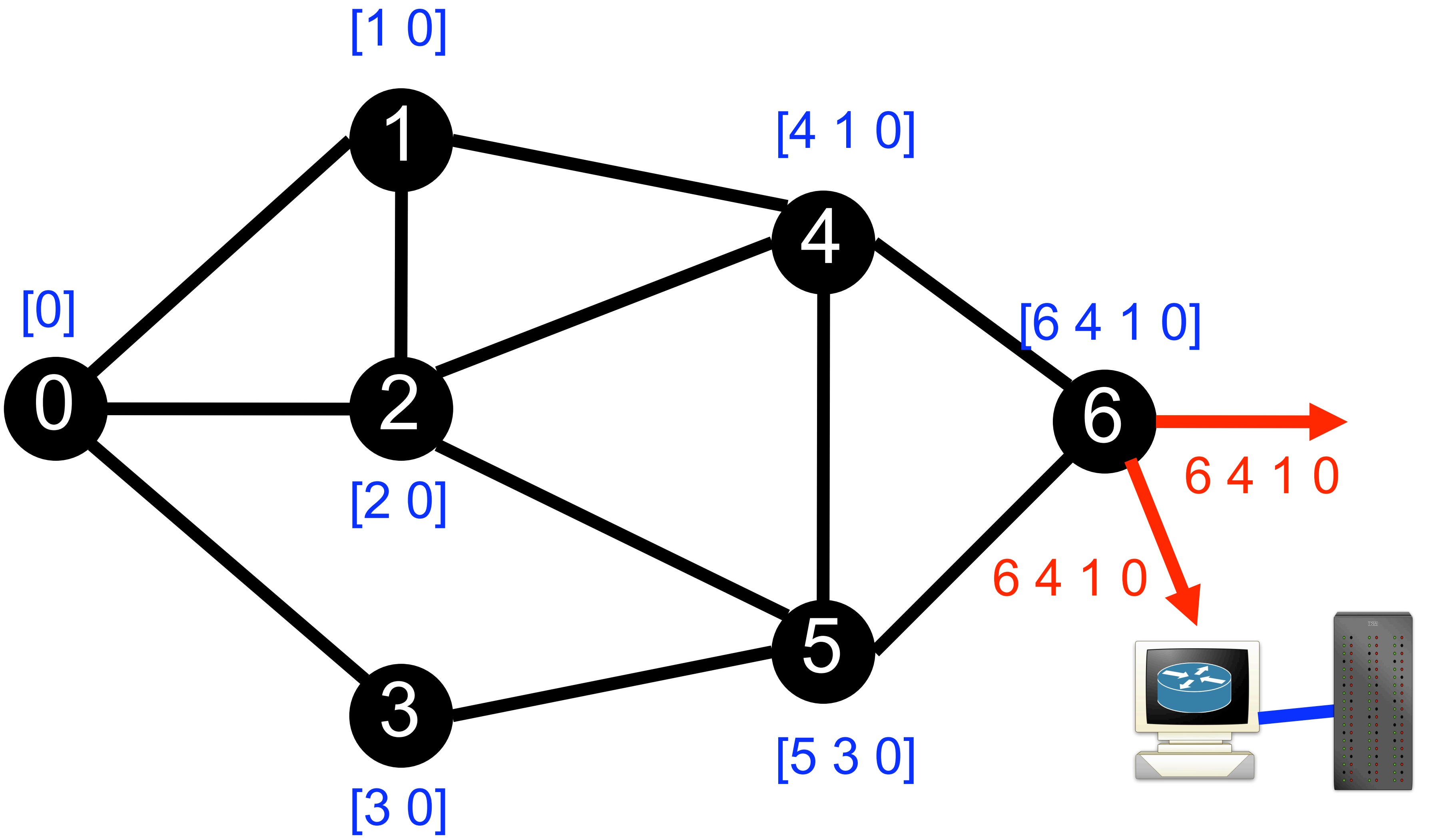
Measurement Artifact 1



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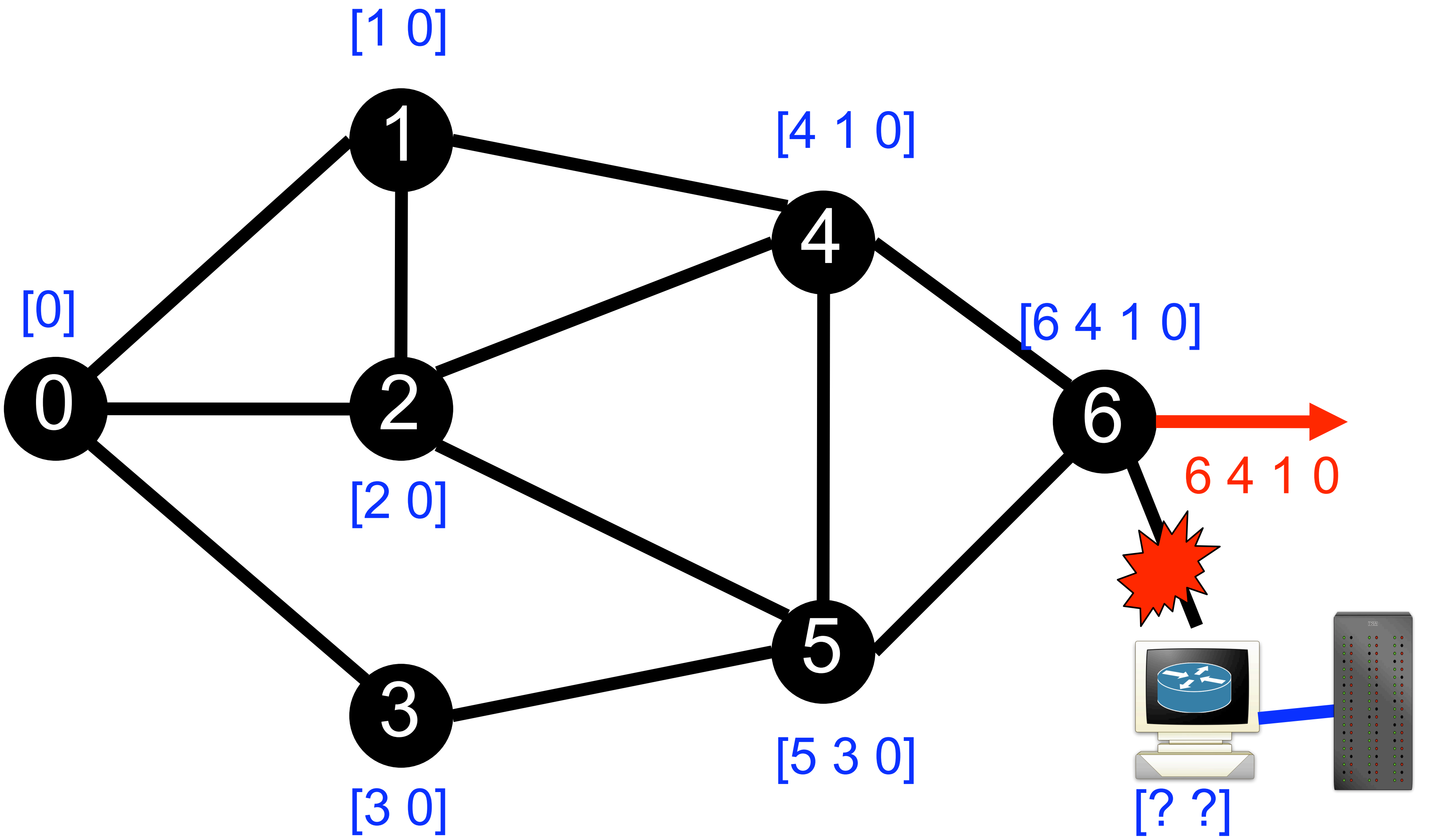
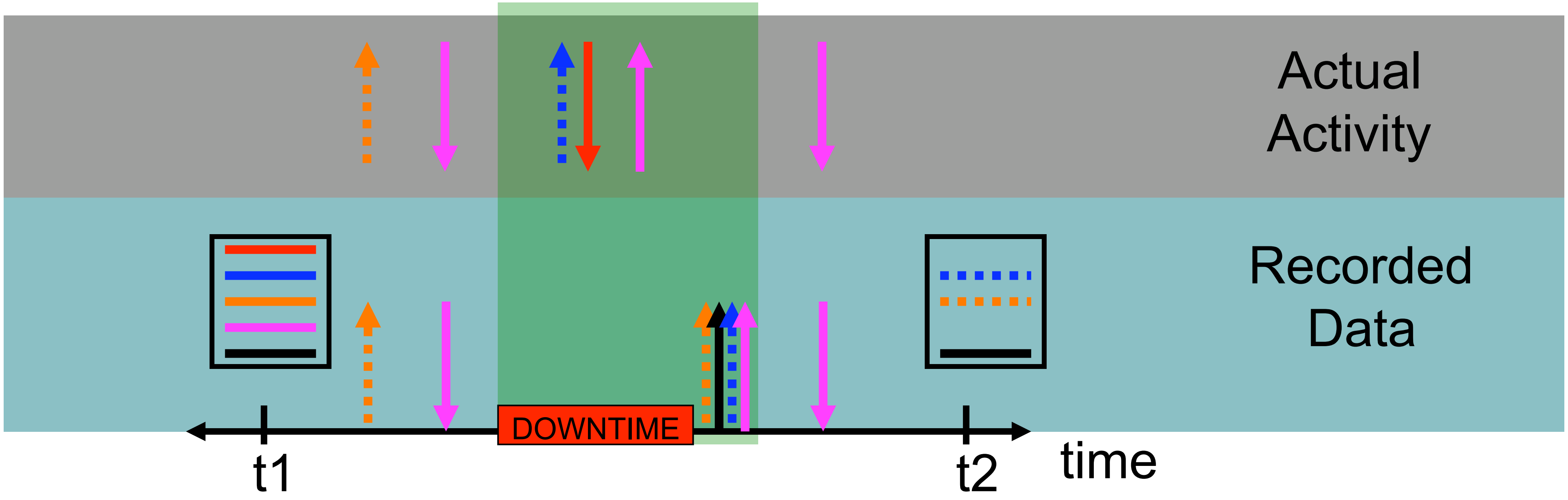


Measurement Artifact 1

- Monitoring Session Reset
  - During downtime, no updates recorded
  - After session reset all routes currently in the table are re-advertised



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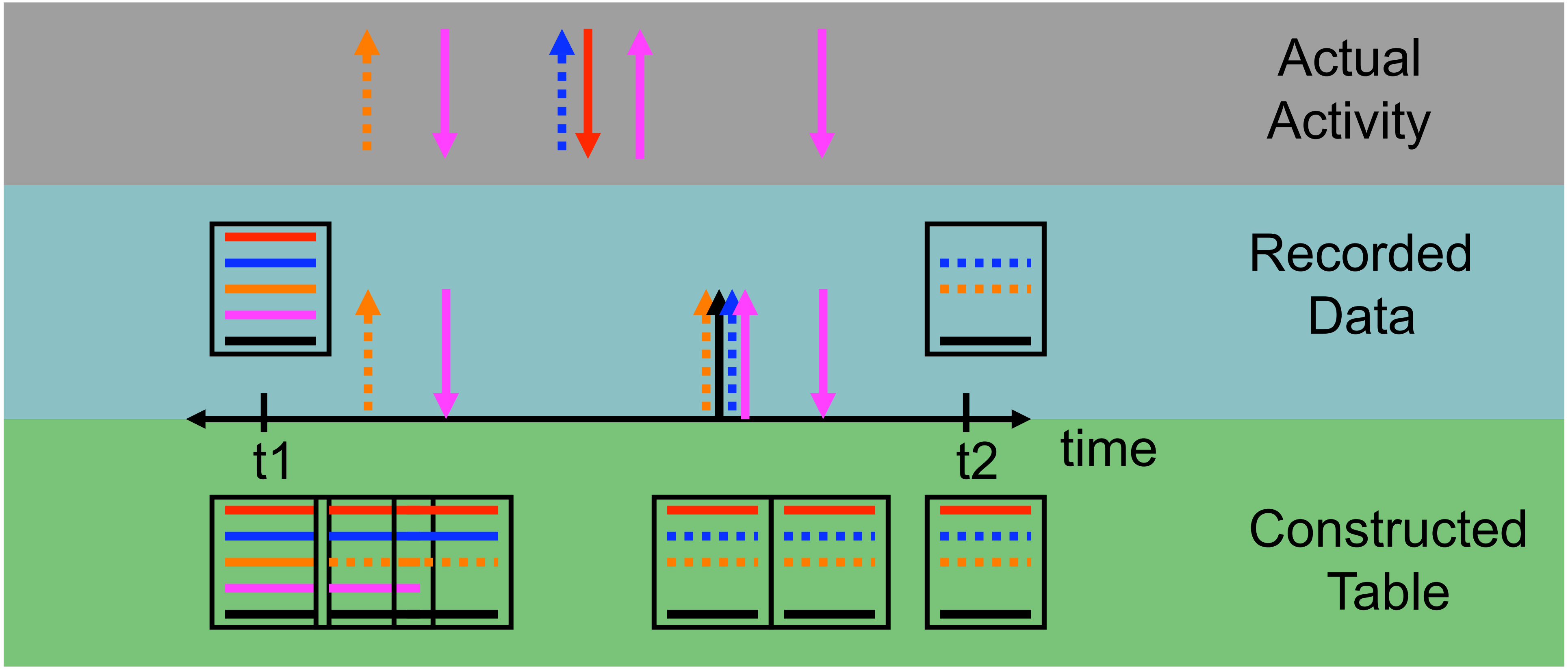
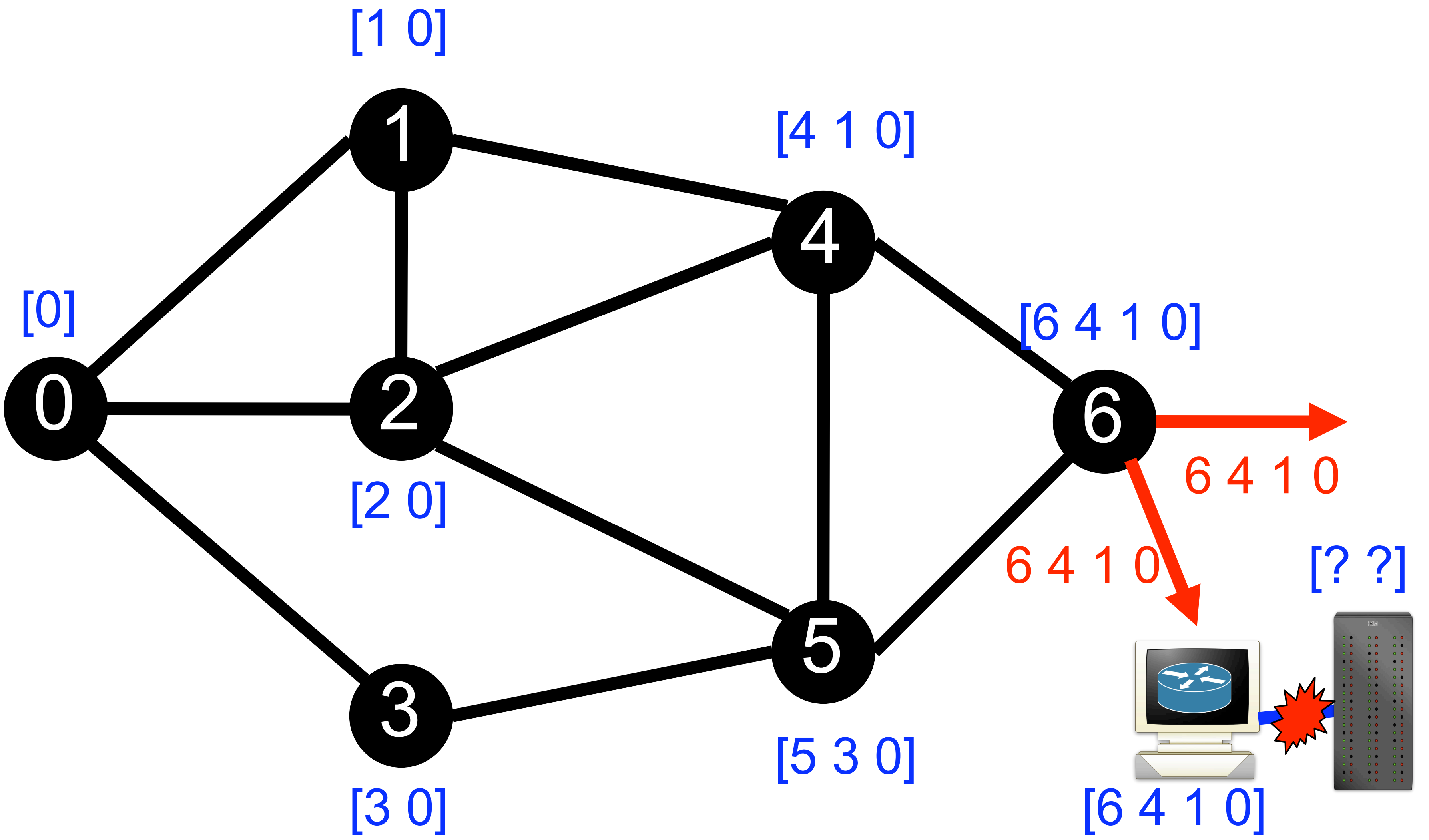


Measurement Artifact 2



Measurement Artifact 2

- Update Re-ordering
  - ‘Almost simultaneous’ updates either
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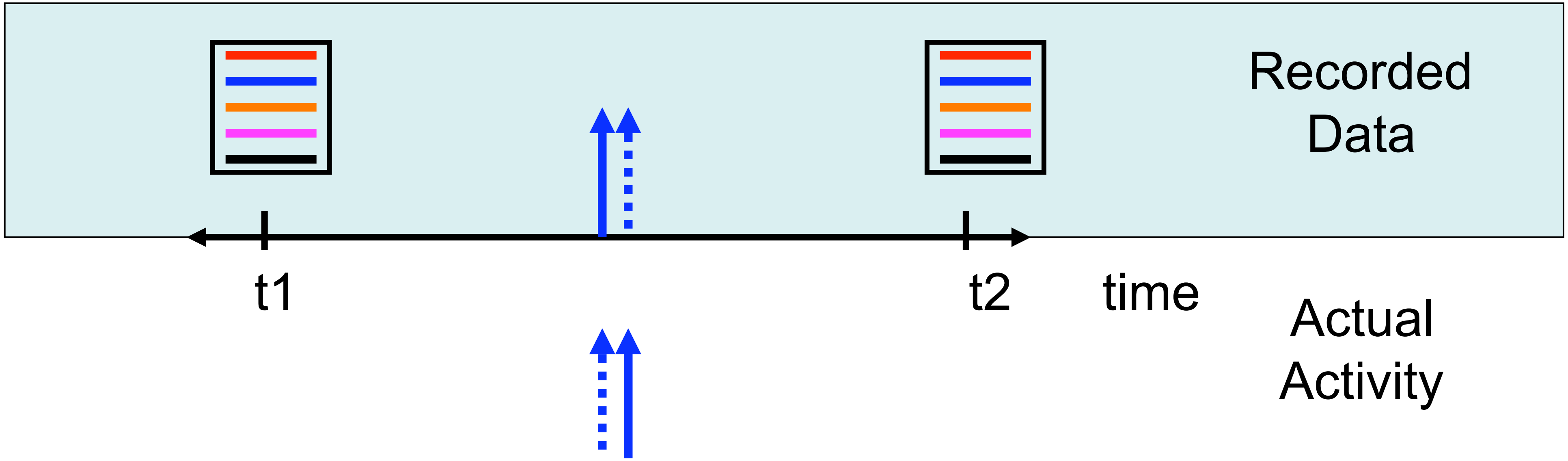
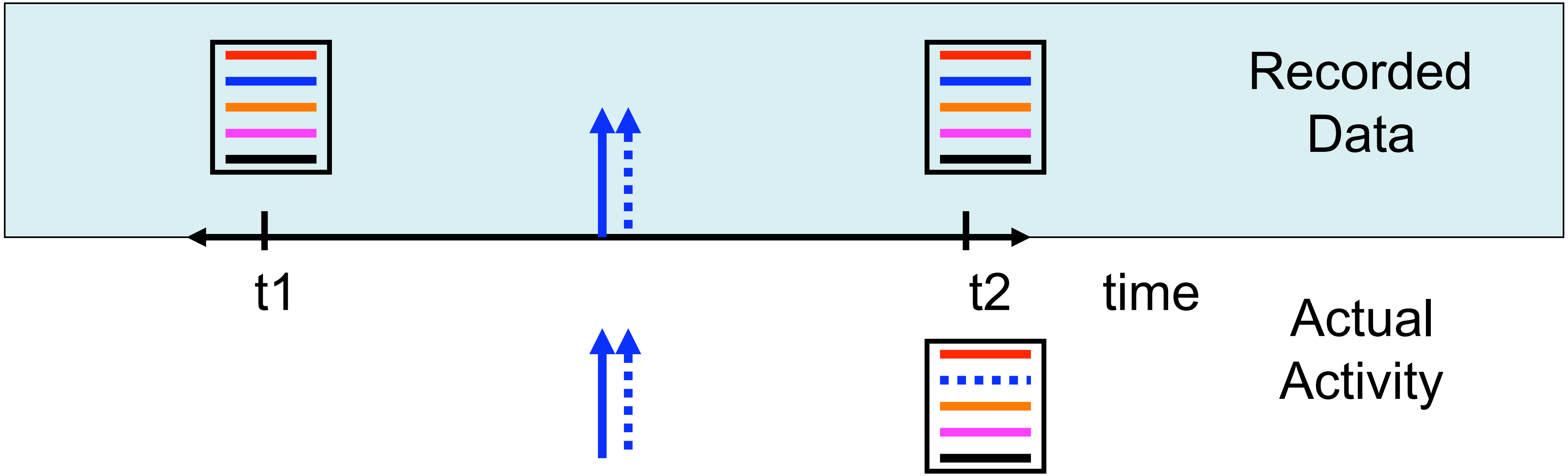


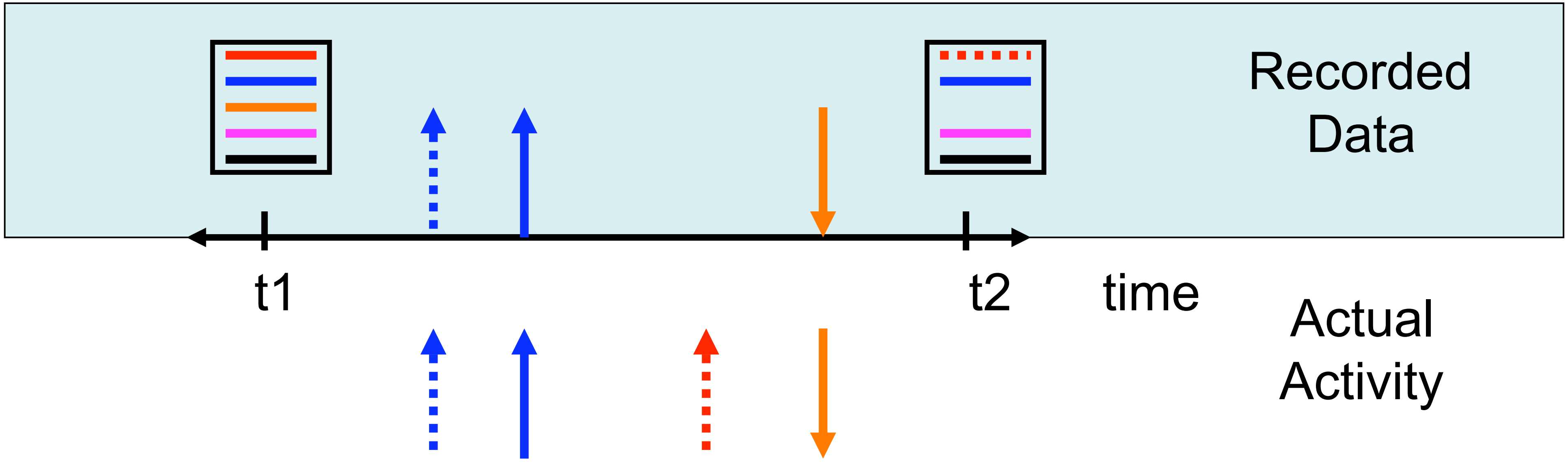
Measurement Artifact 2

- Update Re-ordering
  - ‘Almost simultaneous’ updates either
    - recorded in incorrect order; or
    - applied to table in the incorrect order
      - Serious consequences when software router used as operational router
      - Invalid state!



Other Measurement Artifacts

- Missing Updates
  - Hardware issues prevent all updates being written to data warehouse
- Incomplete Table
  - The table is not written completely to data warehouse



Evidence of Measurement Artifact

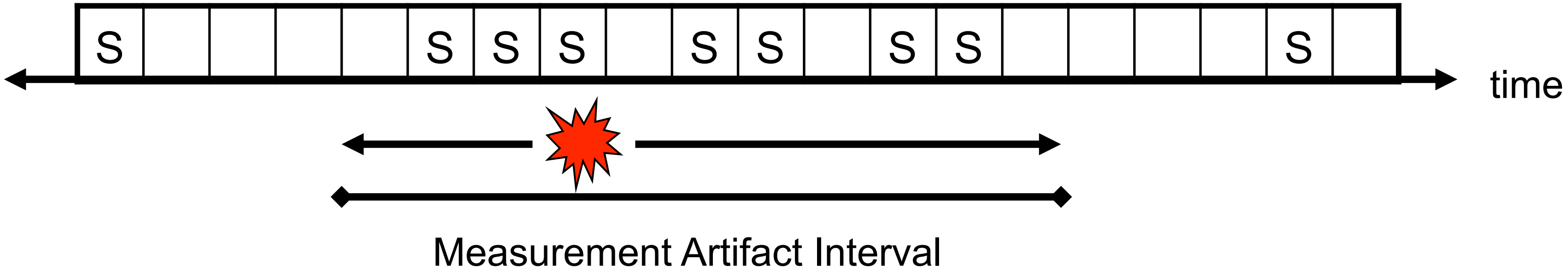
- What do we see in the data?
  - Constructed table differences
  - Almost simultaneous updates
  - No routing activity for extended period
  - Burst of routing announcements
  - State Information
    - Some data sources have session UP/DOWN meta-data.
  - Oldest prefix in table
    - During a session re-establishment ALL prefixes are re-announced.
    - When a session reset definitely did not occur
    - When a session reset may have occurred
- Predict the cause of an inconsistency based on evidence

Detection of Measurement Artifact

- Inconsistency in Constructed and Recorded Table
  - A session reset may not cause an inconsistency!
    - No withdrawals may occur during downtime
    - Still an artifact
      - Re-establishment phase updates
- Sliding window on update timeseries
  - Threshold of duplicates or unique prefixes
  - Downtime
    - Hold-time a good threshold when `keep-alives’ recorded

Localization of Measurement Artifact

- Update timeseries split into bins
- Find group of suspicious bins around detected time
  - Include single ‘normal’ bins
  - Detected time one bin either side of group
  - Captures multiple resets in one interval
- A bin is suspicious if
  - No updates
  - Large number of unique prefixes
  - Large number of duplicates
- Conservative detection/localization provides confidence in data!



Cleaning Data

- Exclusion
  - – Exclude the data affected from further analysis
  - – Recommended
- Estimation
  - – What actually happened?
    - Remove duplicates during measurement artifact interval
    - Place updates where appropriate
      - – Table provides some help here
      - – Mark the updates which we introduce/remove

What Did We Find?

- Analyzed several RIPE monitors for several months
  - Inconsistent data in about 5% of tables
  - 81% of inconsistencies caused by re-ordered updates!
  - Session resets contributed 10% of inconsistencies
    - Much more frequent detection when no inconsistency
    - State information for validation
  - Almost an hour on Jan 21, 2007 where no updates are recorded
    - Not caused by a session reset

Summary

- Important to validate your data!
- Cross-checking provides an increased level of confidence in data
- Developing a tool based on these results
  - Including automatic threshold setting

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- Important to validate your data!
- Cross-checking provides an increased level of confidence in data
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- I’m looking for a job ☺