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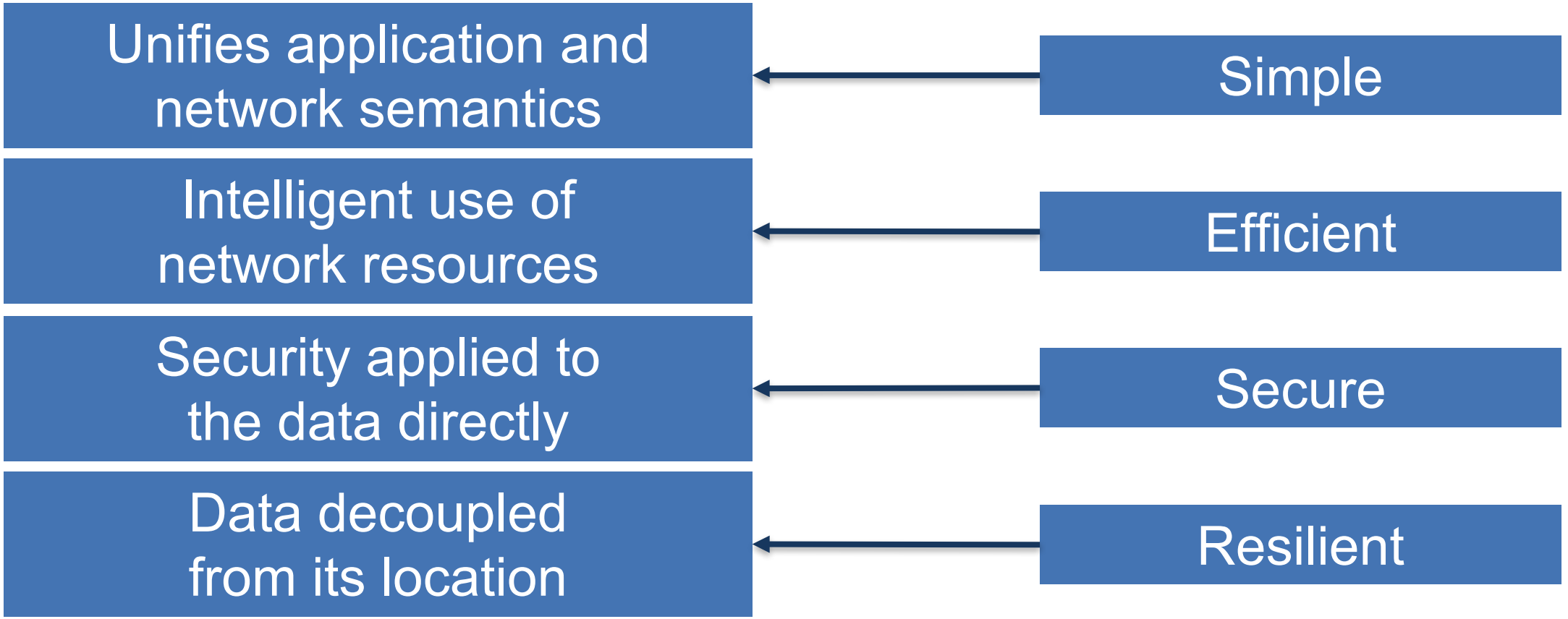
MILITARY COMMUNICATIONS AND INNOVATION - PRIORITIES FOR THE MODERN WARFIGHT

Evaluating NDN in a Notional Tactical Networks

BALTIMORE, MD • OCTOBER 23–25, 2017

Why NDN for a tactical environment?



Why NDN for a tactical environment?

- A lot of tactical applications are inherently content-centric
  - E.g. Blue force tracking
  - Overlay solutions already in place that attempt to bring the data closer to its consumers
    - Complicate the network
    - Not too efficient

Why NDN for a tactical environment?

- Data dissemination in a lot of cases is one-to-many
  - E.g. Multicast TADIL-J
  - Multicast protocols are complex and lack resiliency

Why NDN for a tactical environment?

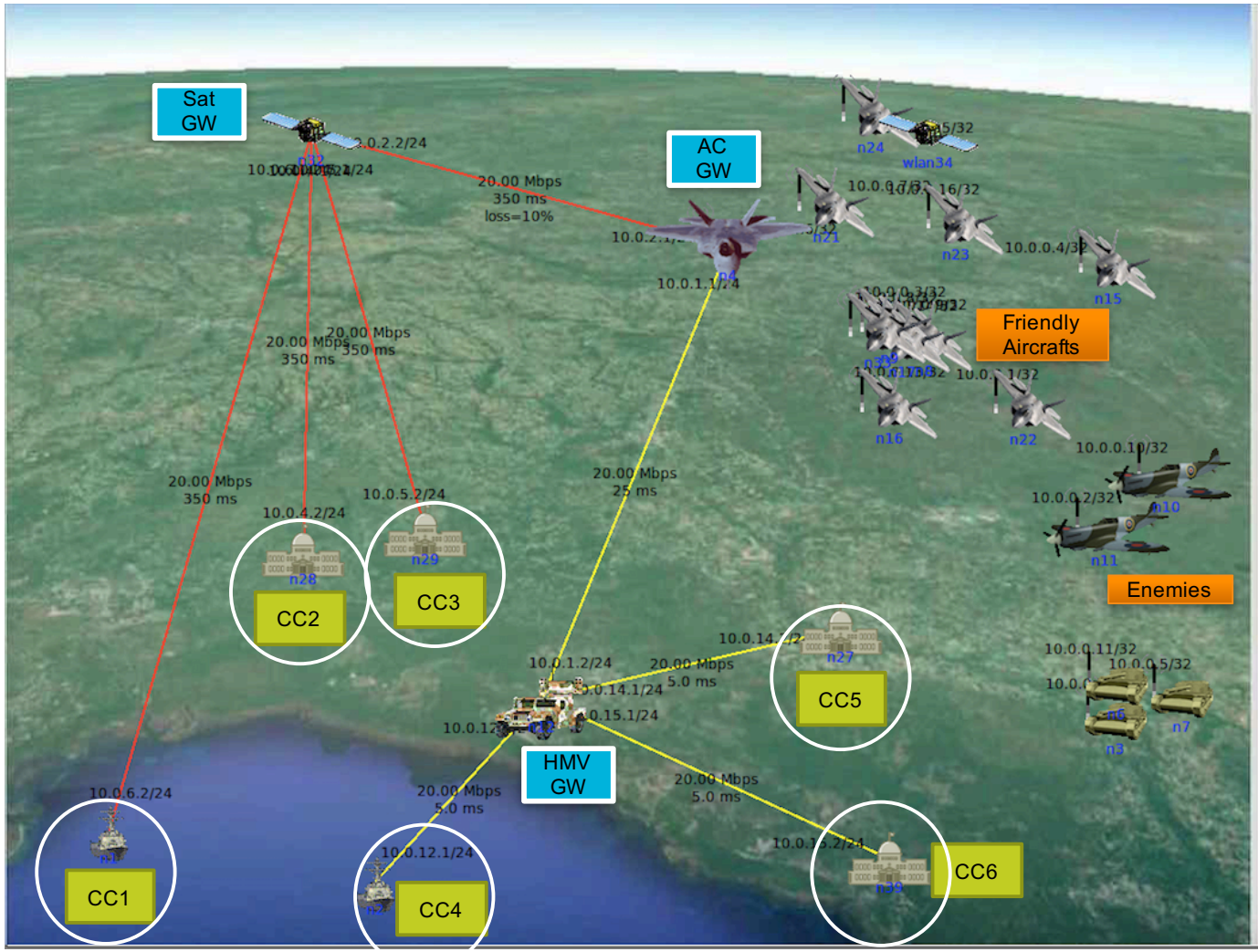
- Data analytics is making its way into the tactical edge
  - E.g. Naval Tactical Cloud
  - Complex algorithms to extract the semantics of the data

How does NDN compare to legacy protocols?

- Evaluate NDN in a notional USAF scenario
- Objective: evaluate resiliency in a highly disrupted environment

Evaluating NDN

- 6 Command Centers (yellow)
- 3 Gateways (in blue)
- 10 friendly aircrafts
- 2 enemy aircrafts
- 3 enemy tanks
- Links with varying characteristics
- Data transfer from CCs to AC



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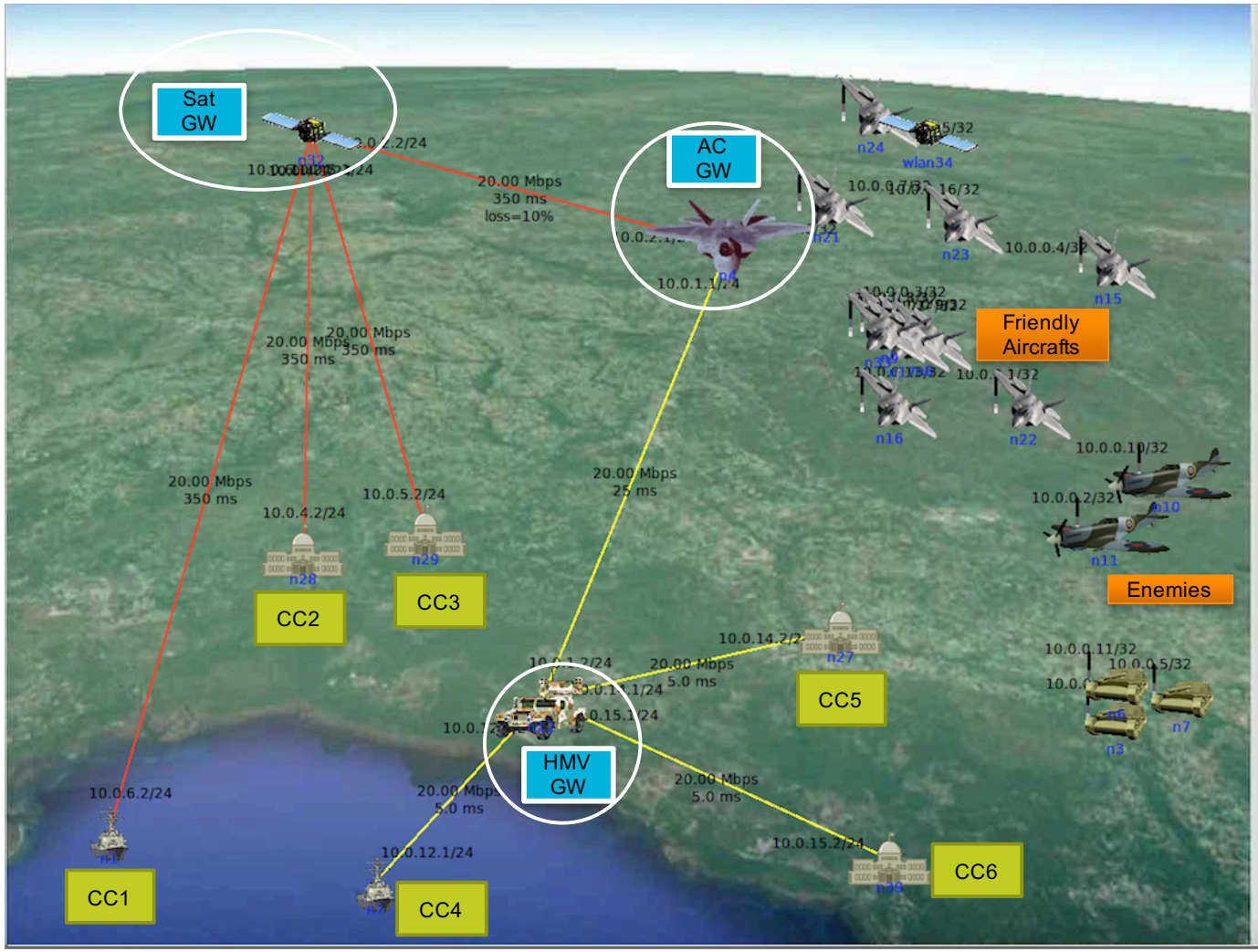

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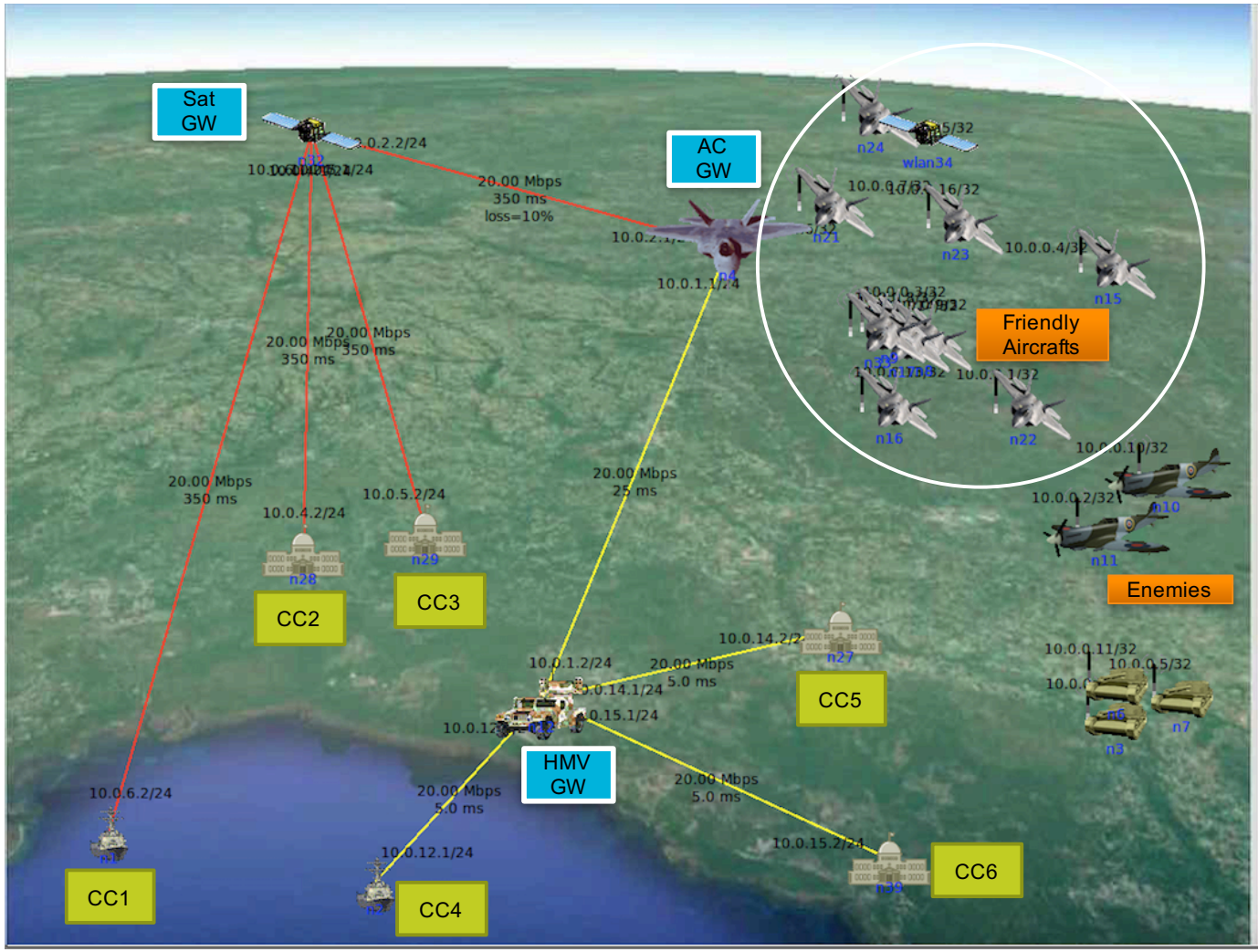

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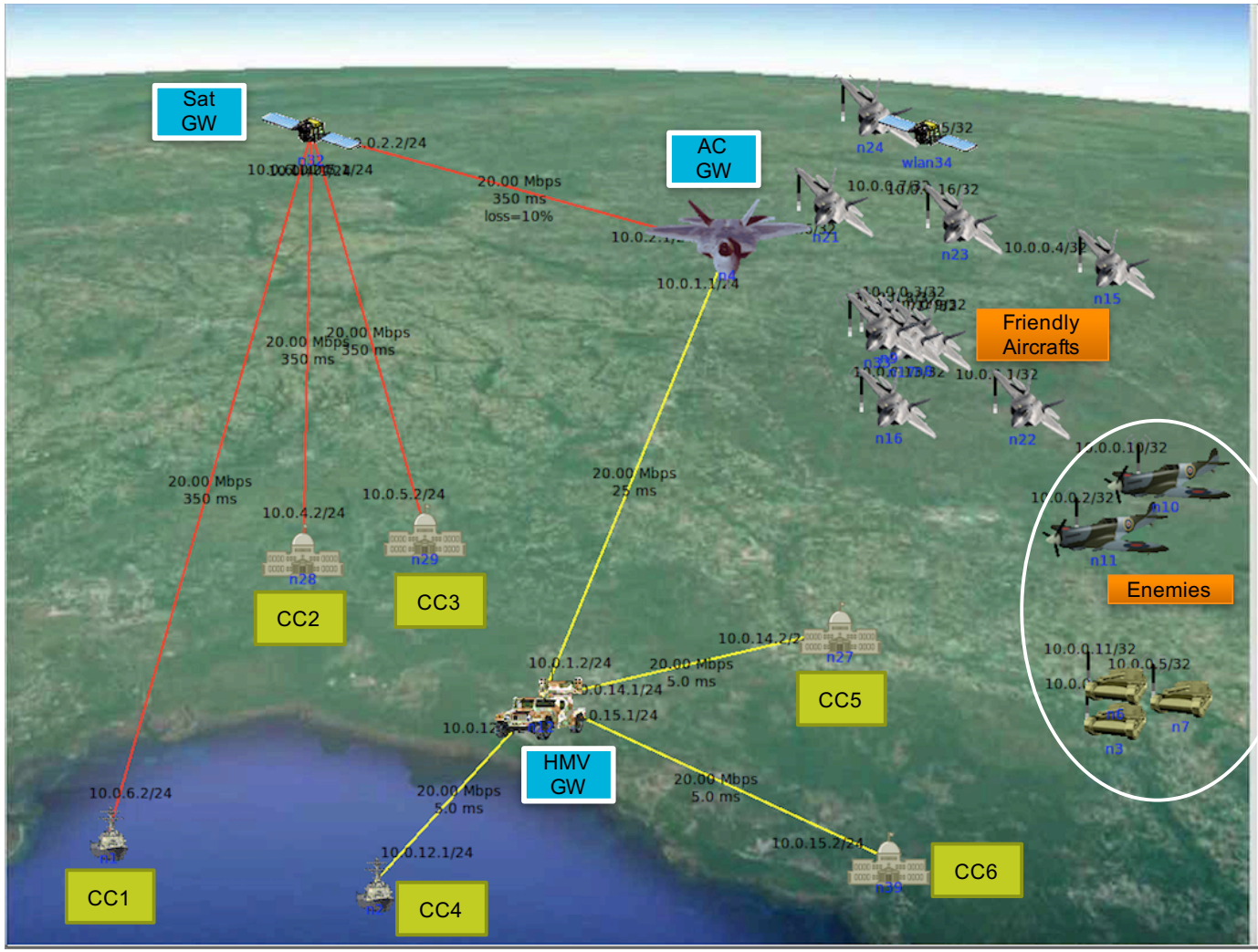

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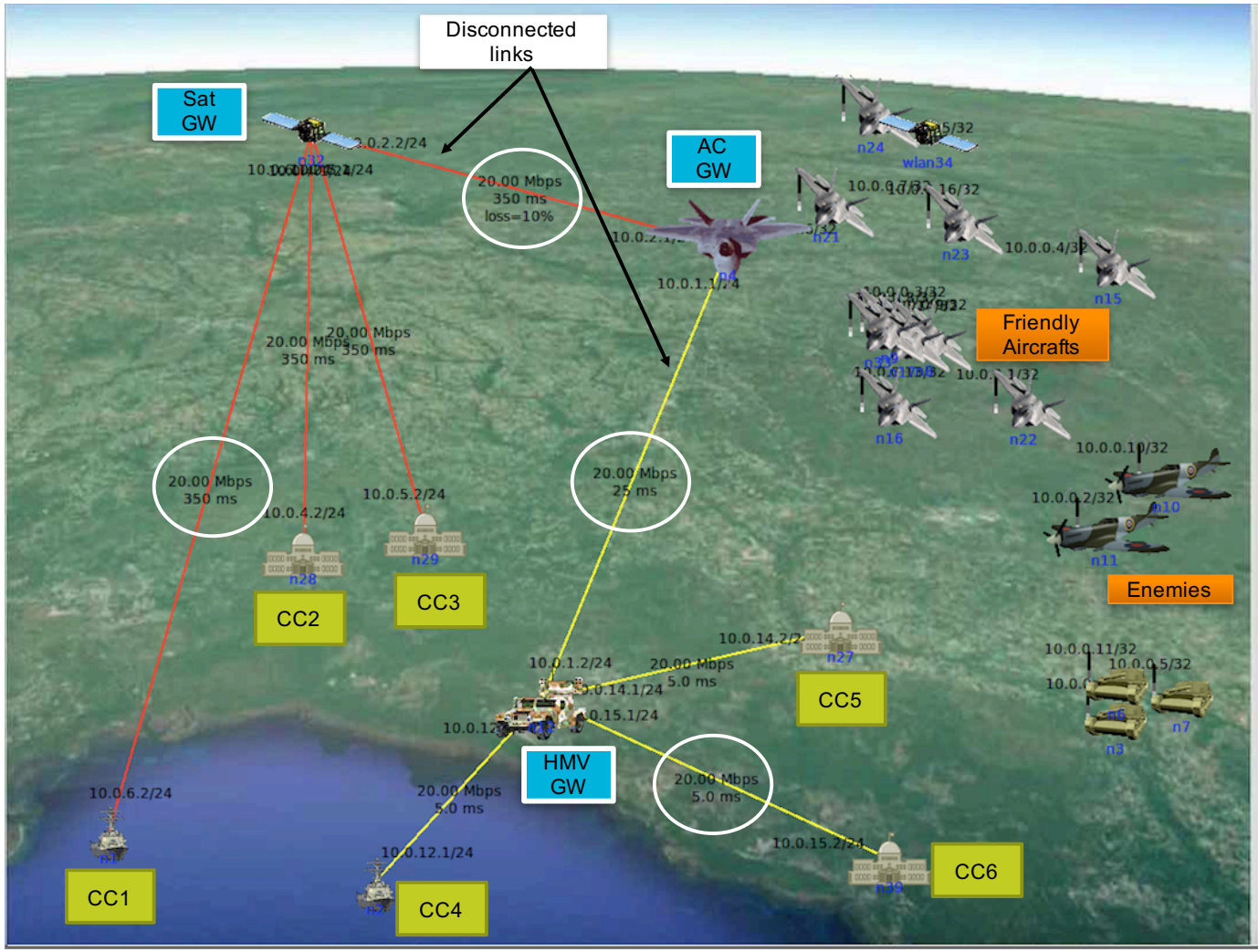

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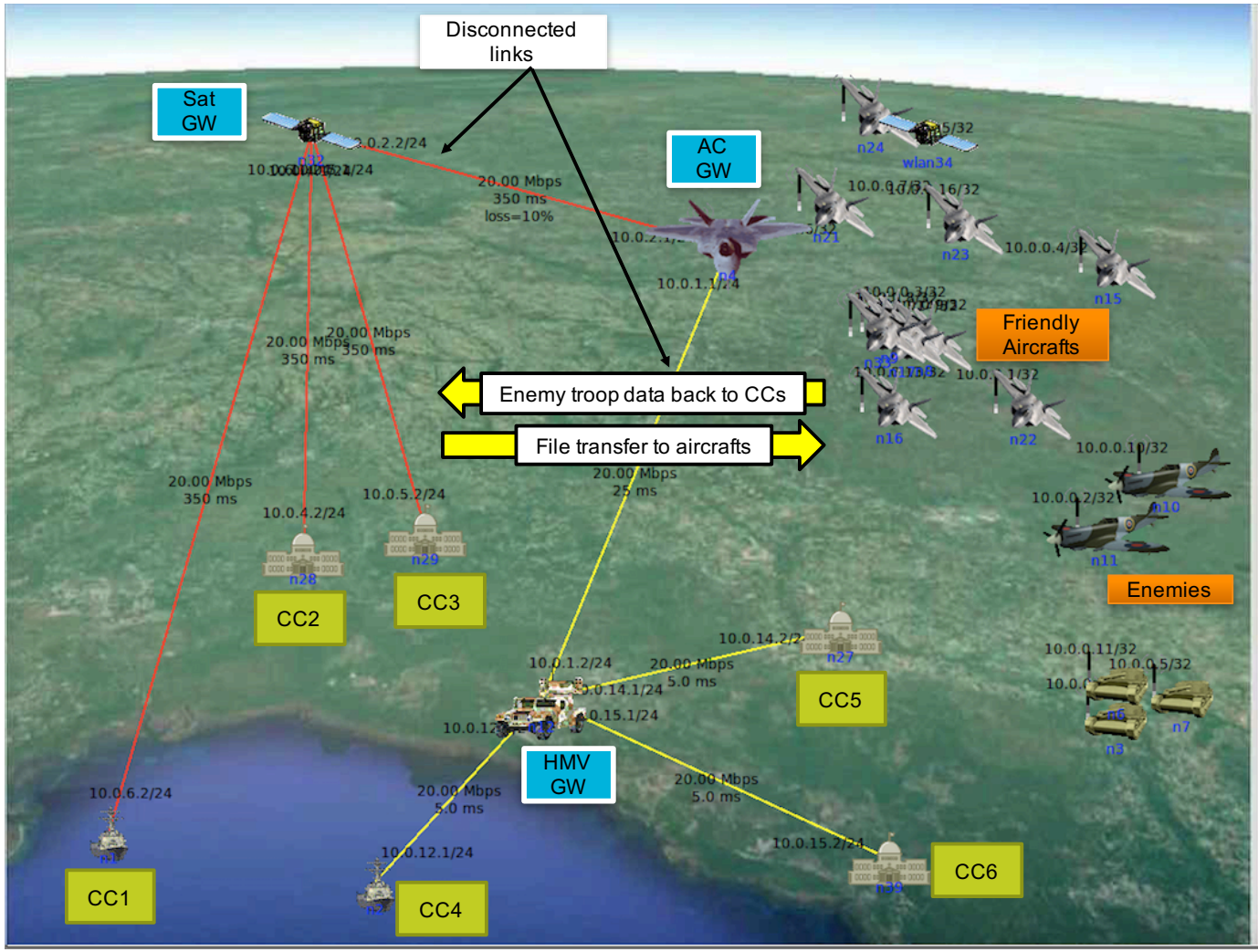
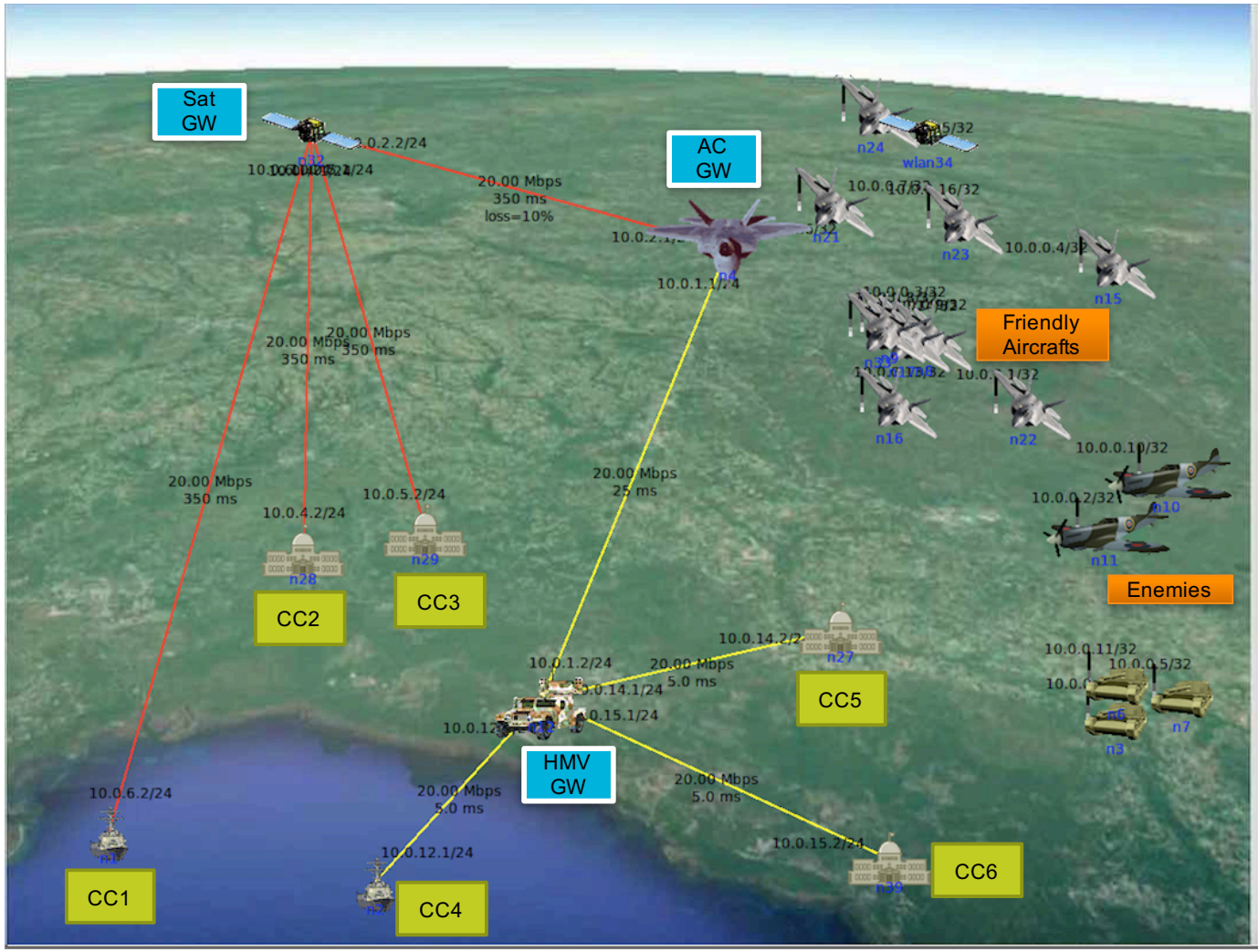


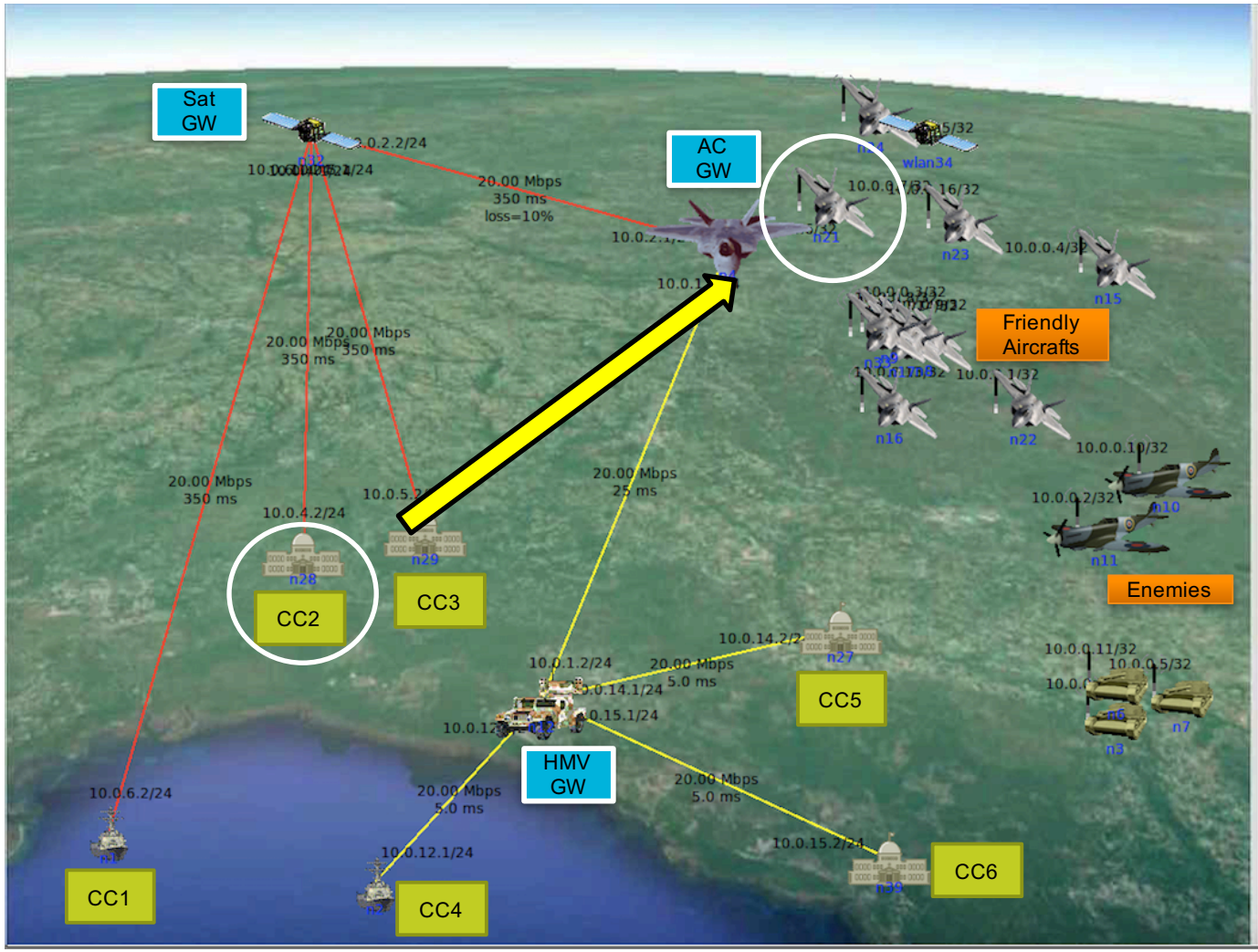
Evaluating NDN: Traffic Model

- Data transport through:
  - TFTP over UDP/IP
  - NORM over UDP/IP
  - SCPS-TP over IP
  - NDN over IP or Ethernet
- 20 minute runs using CORE



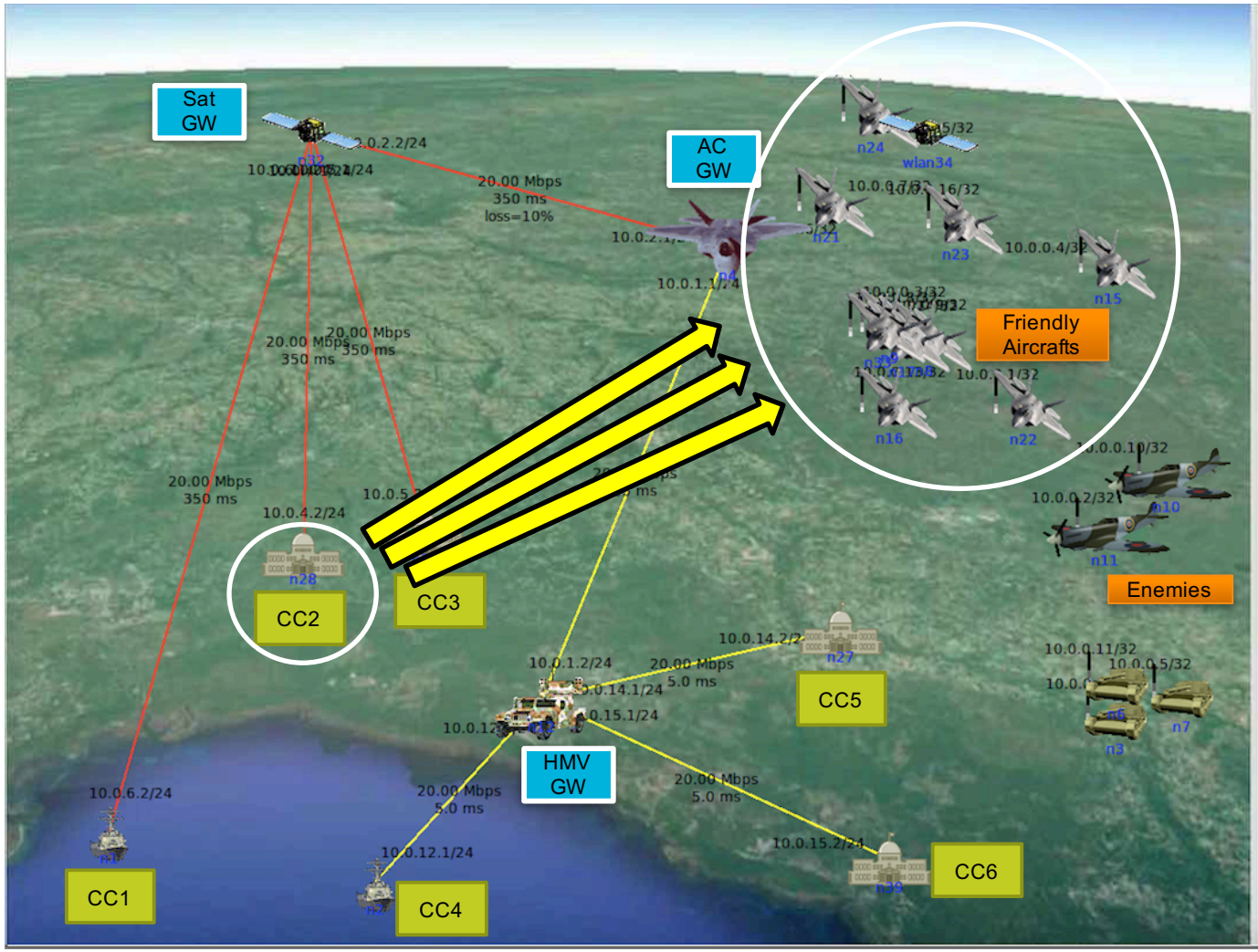
Evaluating NDN: Traffic Model

- Large file transfer A:
  - From CC2 to one randomly selected aircraft
  - Every 2-3 minutes (total of 8 files/1MB each)
  - Files only valid within 3 minutes of their generation



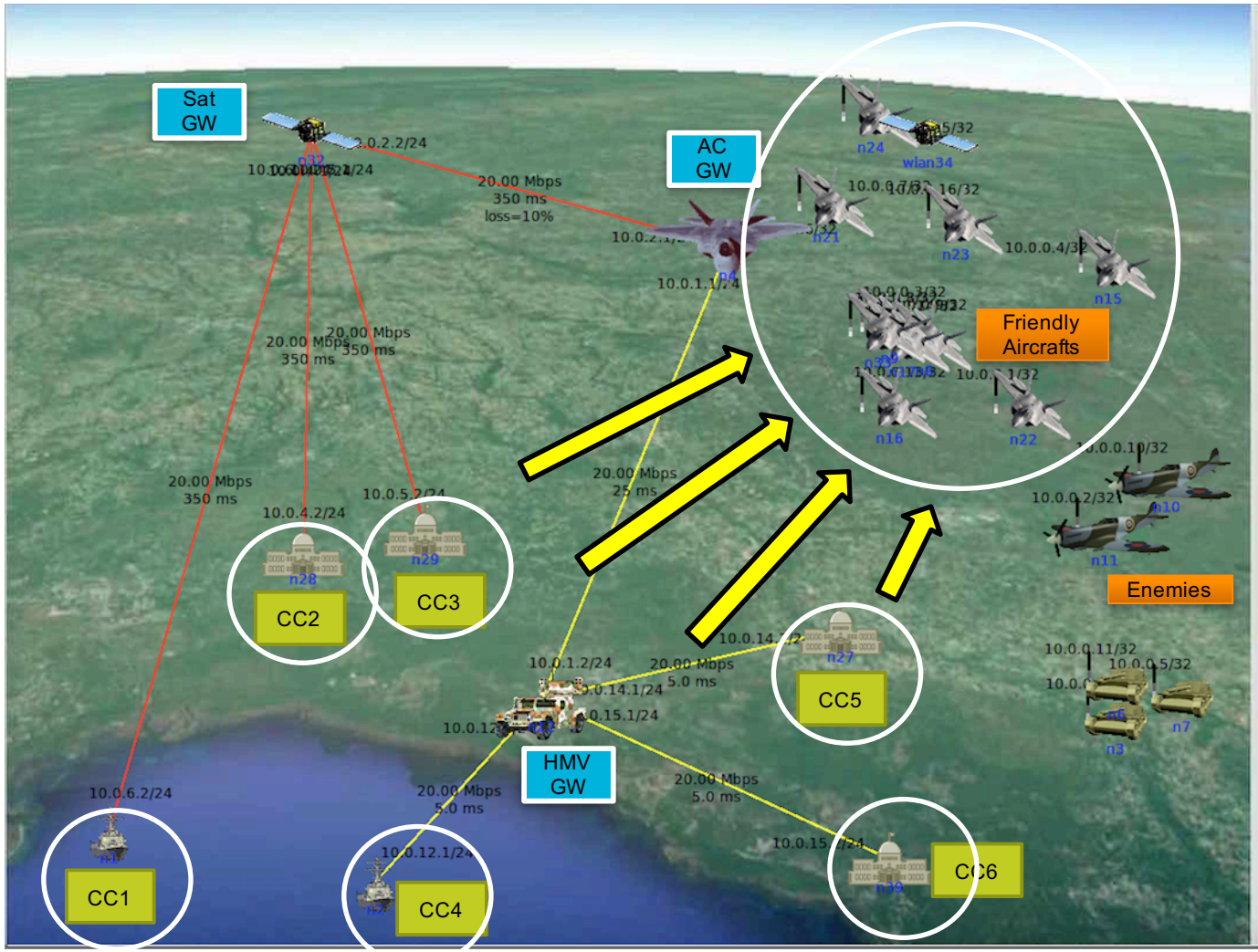
Evaluating NDN: Traffic Model

- Large file transfer B:
  - From CC2 to all aircrafts
  - Every 2-3 minutes (total of 8 files/1MB each)
  - Files only valid within 3 minutes of their generation



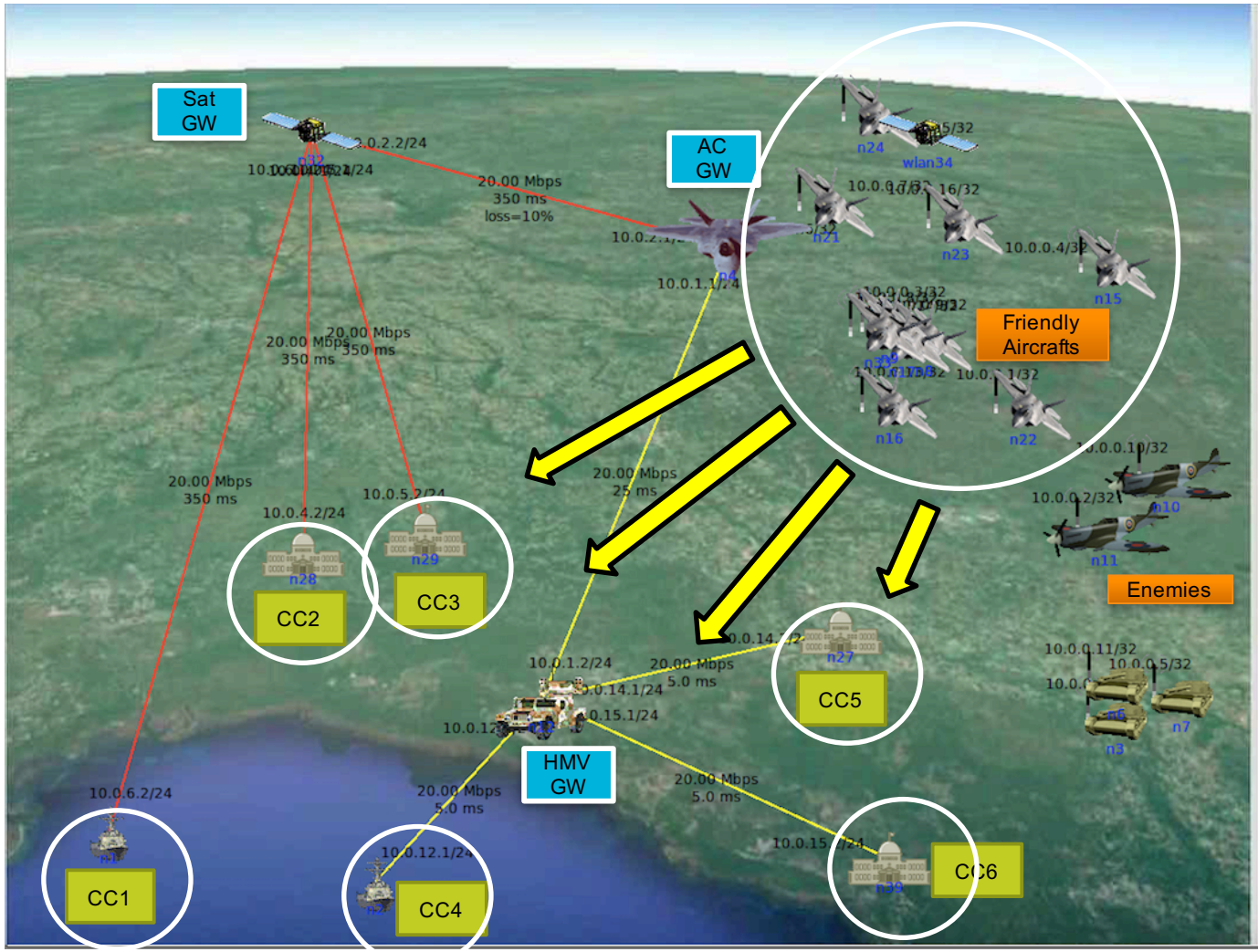
Evaluating NDN: Traffic Model

- Small file transfer:
  - From all CCs to all aircrafts
  - Every 6 seconds (total of 900 files/15KB each)



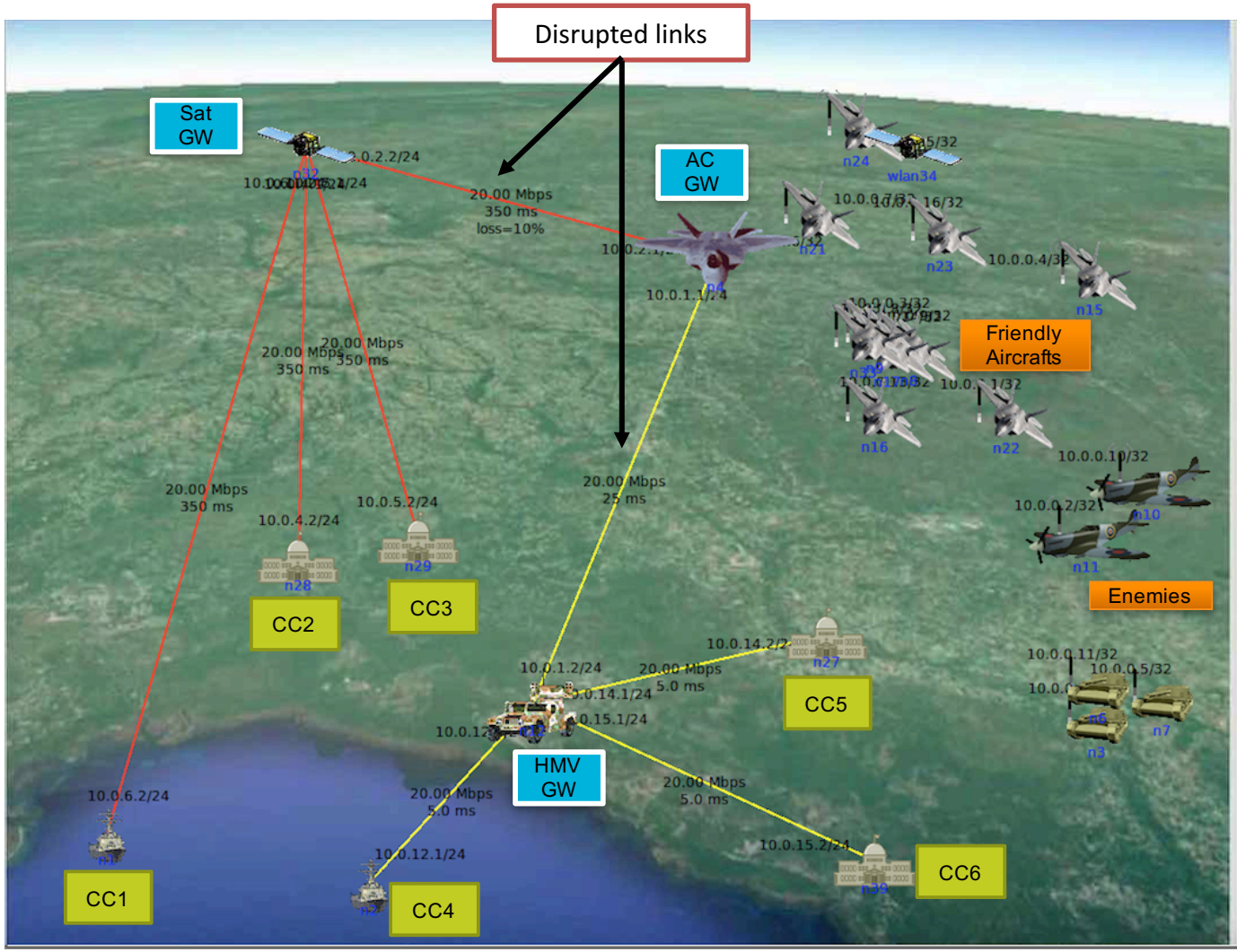
Evaluating NDN: Traffic Model

- PLI data
  - From all aircrafts to all other aircrafts and all CCs
  - Sent over IP multicast first
  - AC-GW caches as NDN packets and forwards as IP multicast
  - Lost data pulled by receivers from NDN caches



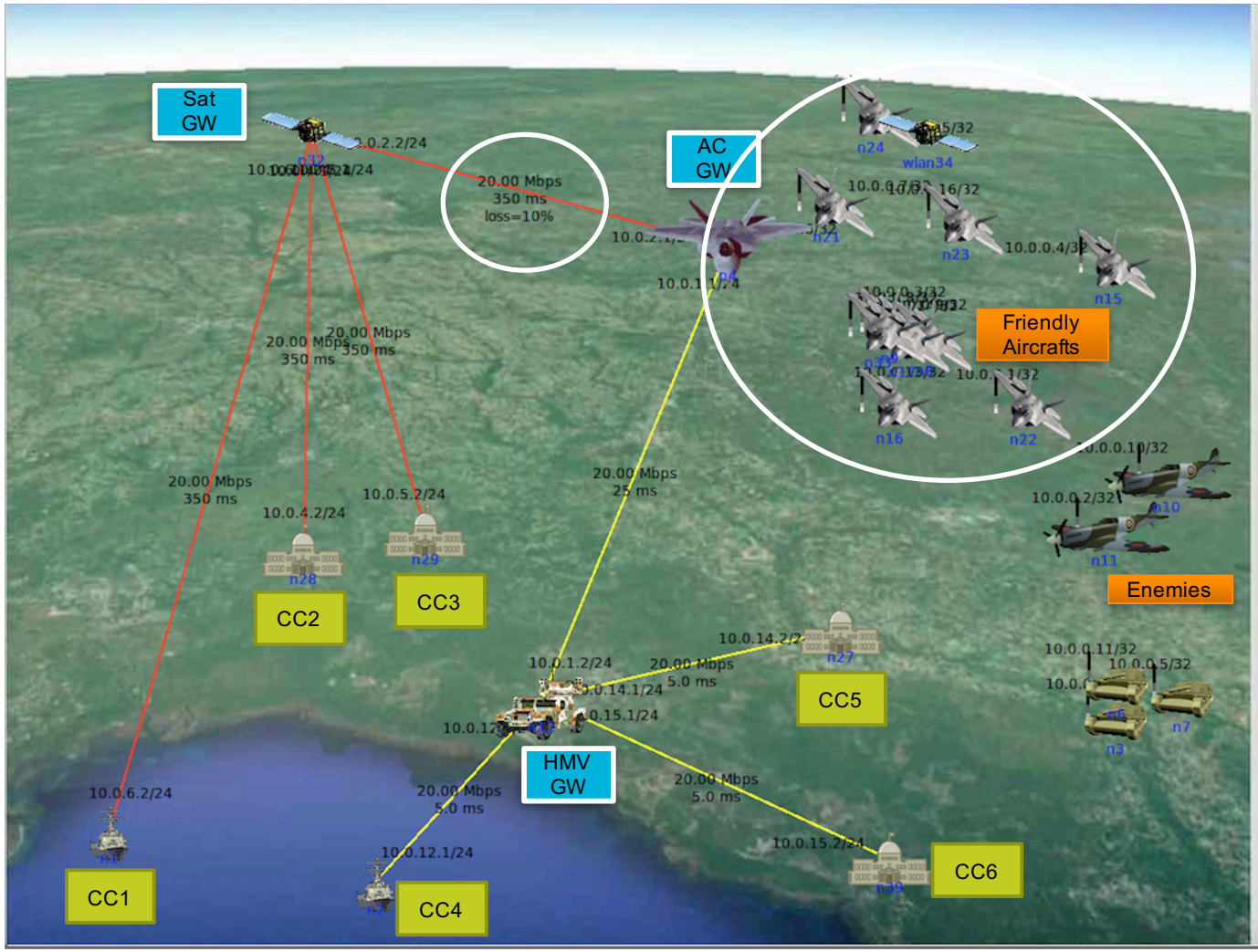
Evaluating NDN: Mobility & Connectivity

- Aircrafts move randomly and independently
- Satellite ⟺ AC-GW link is down for 2 min every 5 min
- HMV ⟺ AC-GW link is down for 30 sec every 2 min



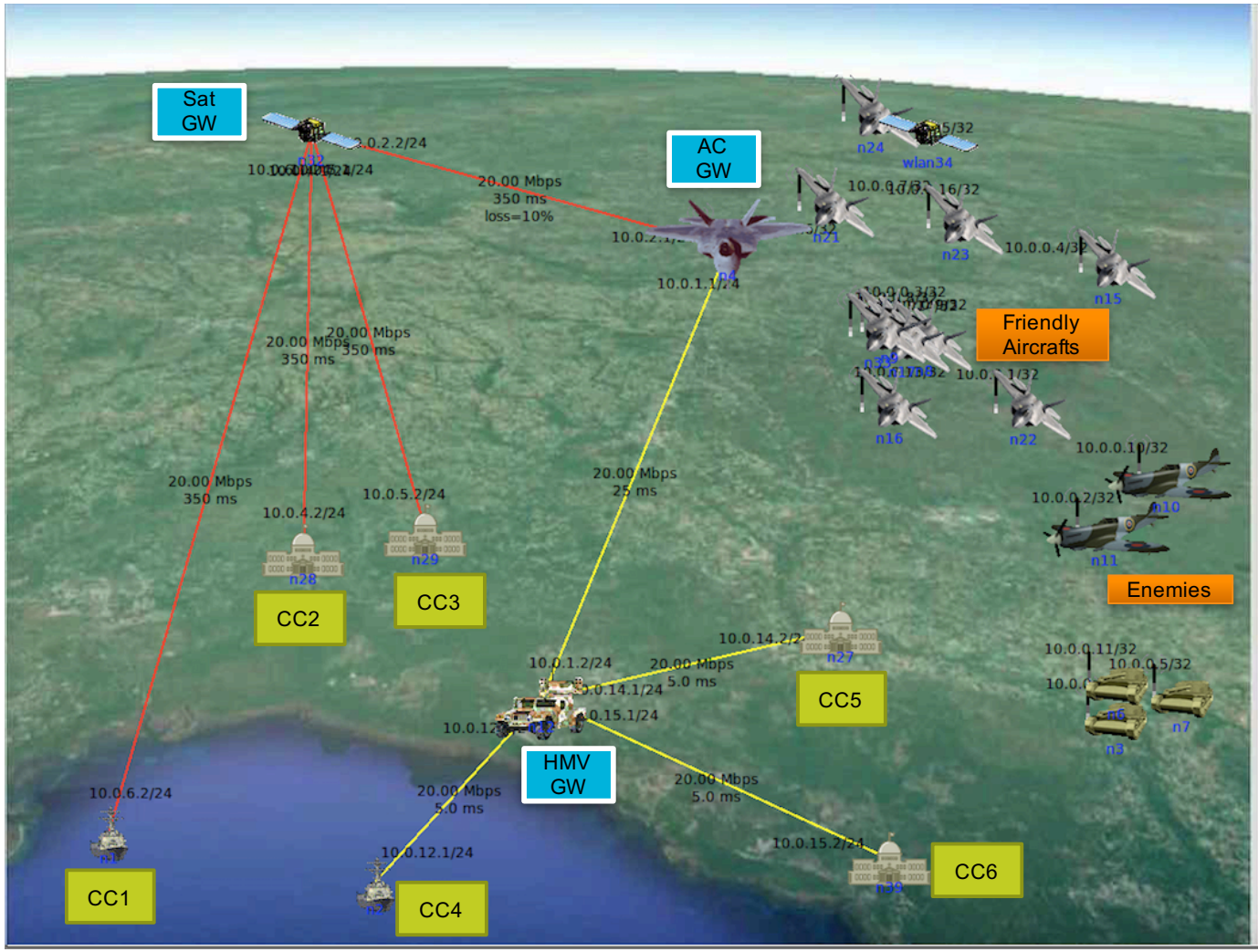
Evaluating NDN: Mobility & Connectivity

- 10% packet loss on Sat-GW ⟺ AC-GW link
- 10% packet loss on AC-GW ⟺ aircrafts links
  - 2Mbps links with 20ms delay



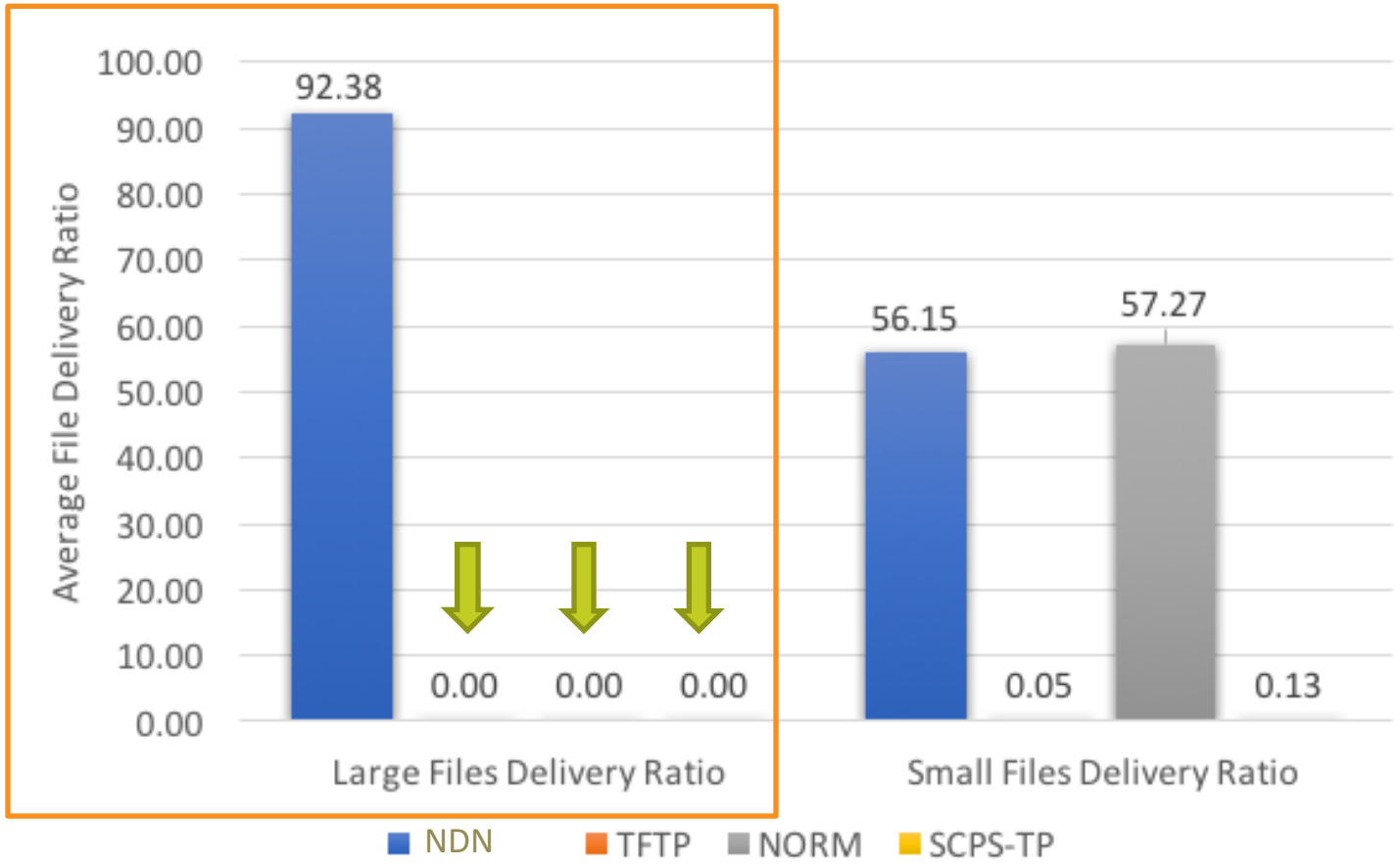
Evaluating NDN: Evaluation Metrics

- File delivery ratio
- File delivery delay
- Transport efficiency
  - Total data delivered/Total data moved across a link



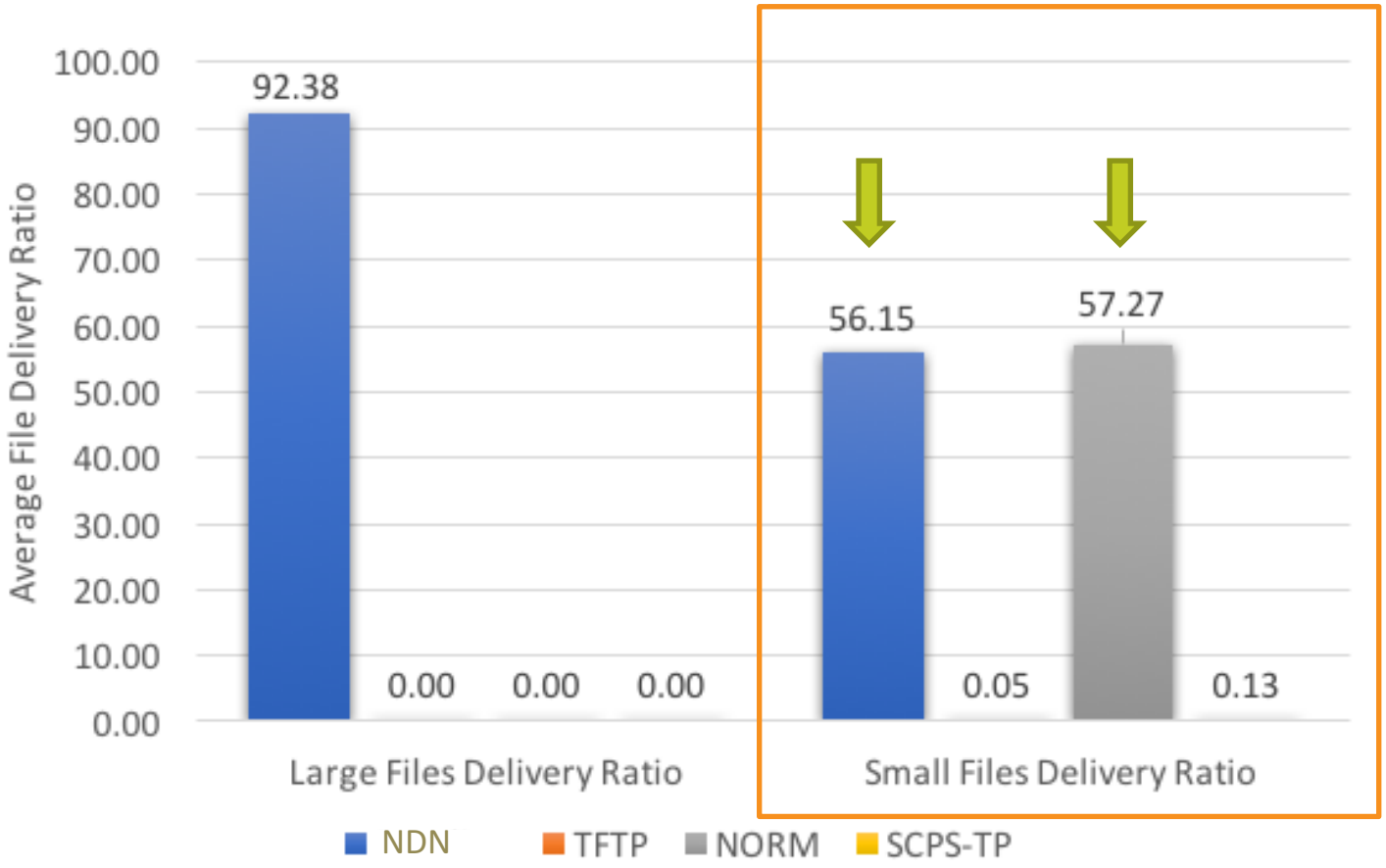
Evaluating NDN: File Delivery Ratio

- NDN delivered > 90%
  - Benefits from in-network caching
- Other mechanism failed
  - Dependent on end-to-end connectivity



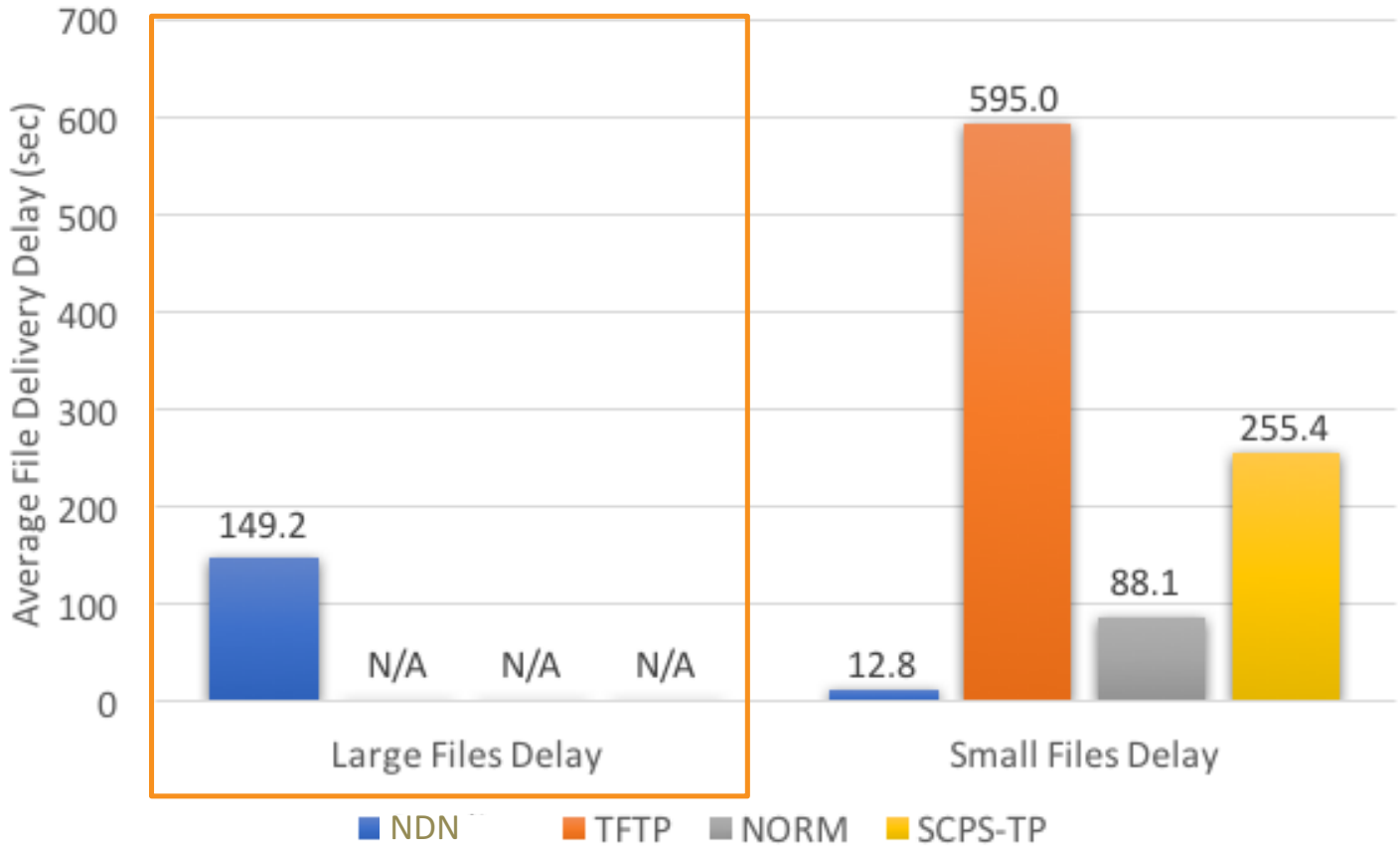
Evaluating NDN: File Delivery Ratio

- Link outages prohibited the delivery of all 900 files
- NORM performed similar to NDN



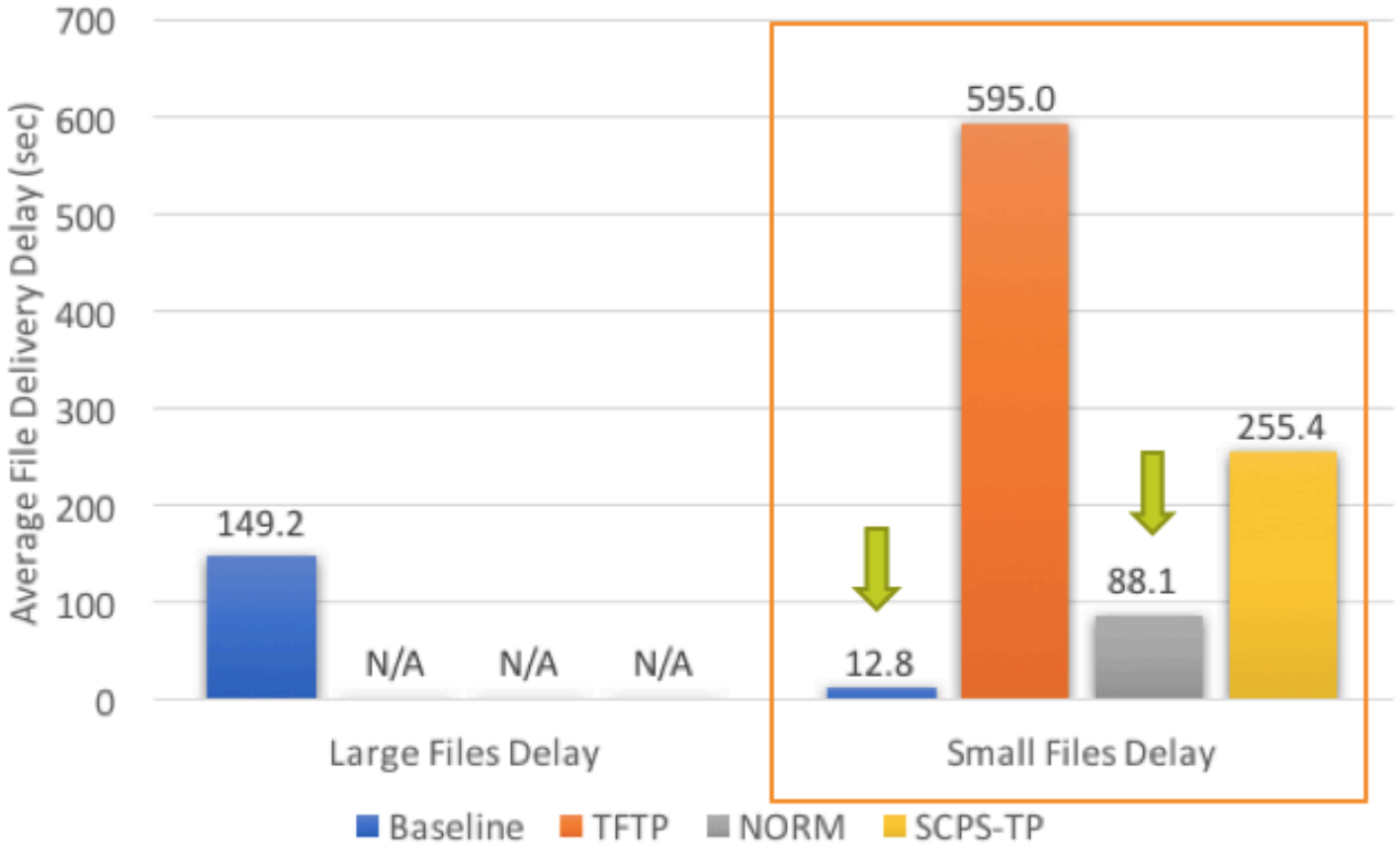
Evaluating NDN: File Delivery Delay

- 2.5 minutes on average to retrieve a large file

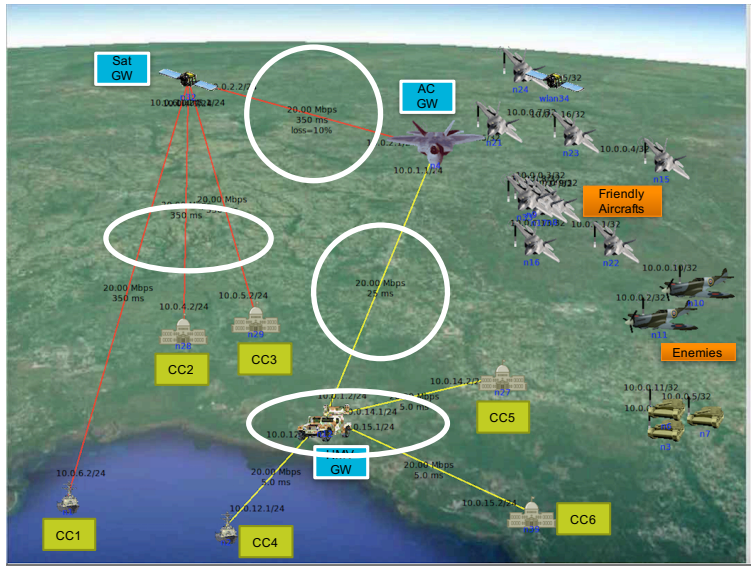


Evaluating NDN: File Delivery Delay

- Much higher delay for NORM in comparison to NDN
  - End-to-end NACKs vs. in-network caching

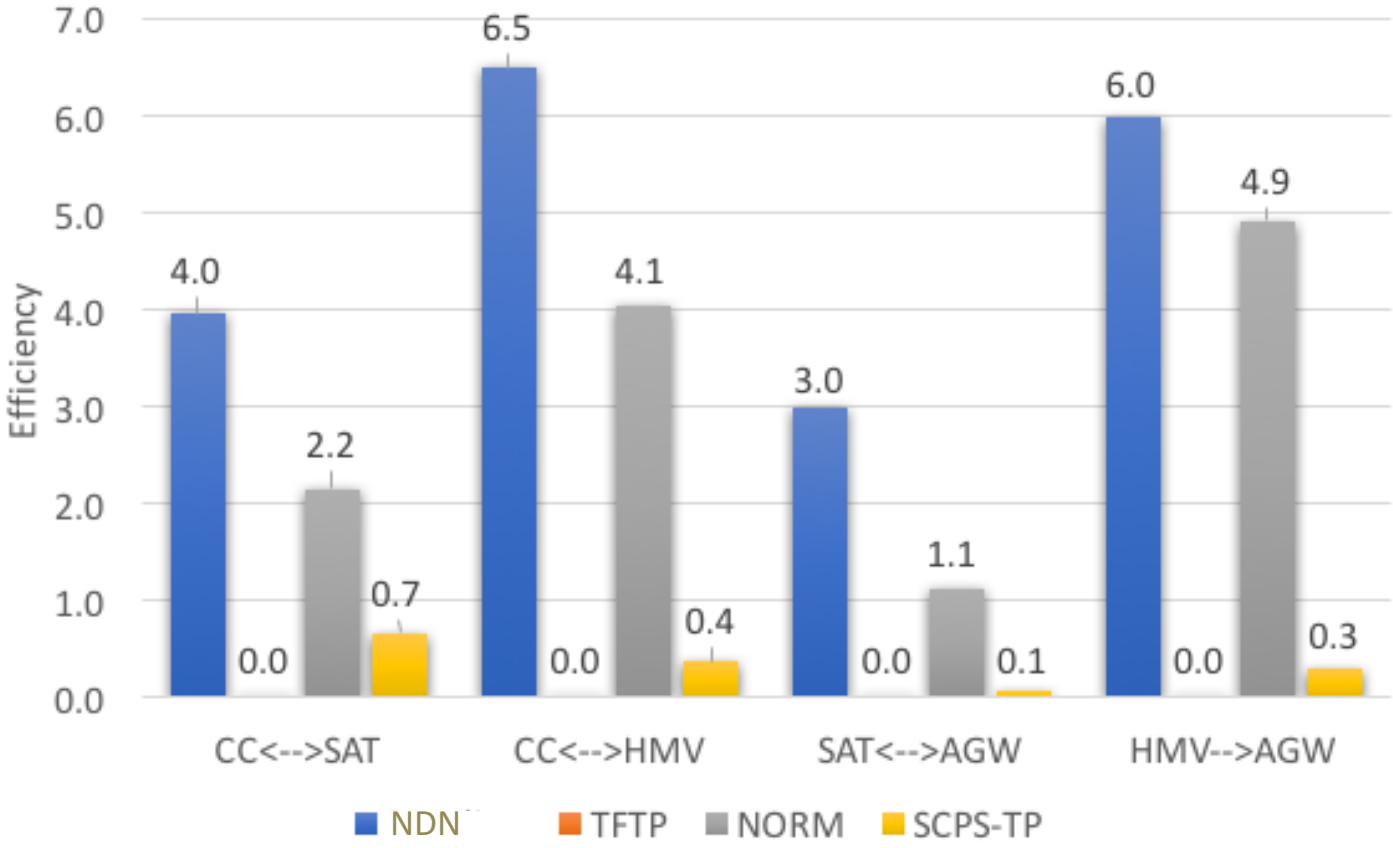


Evaluating NDN: Efficiency



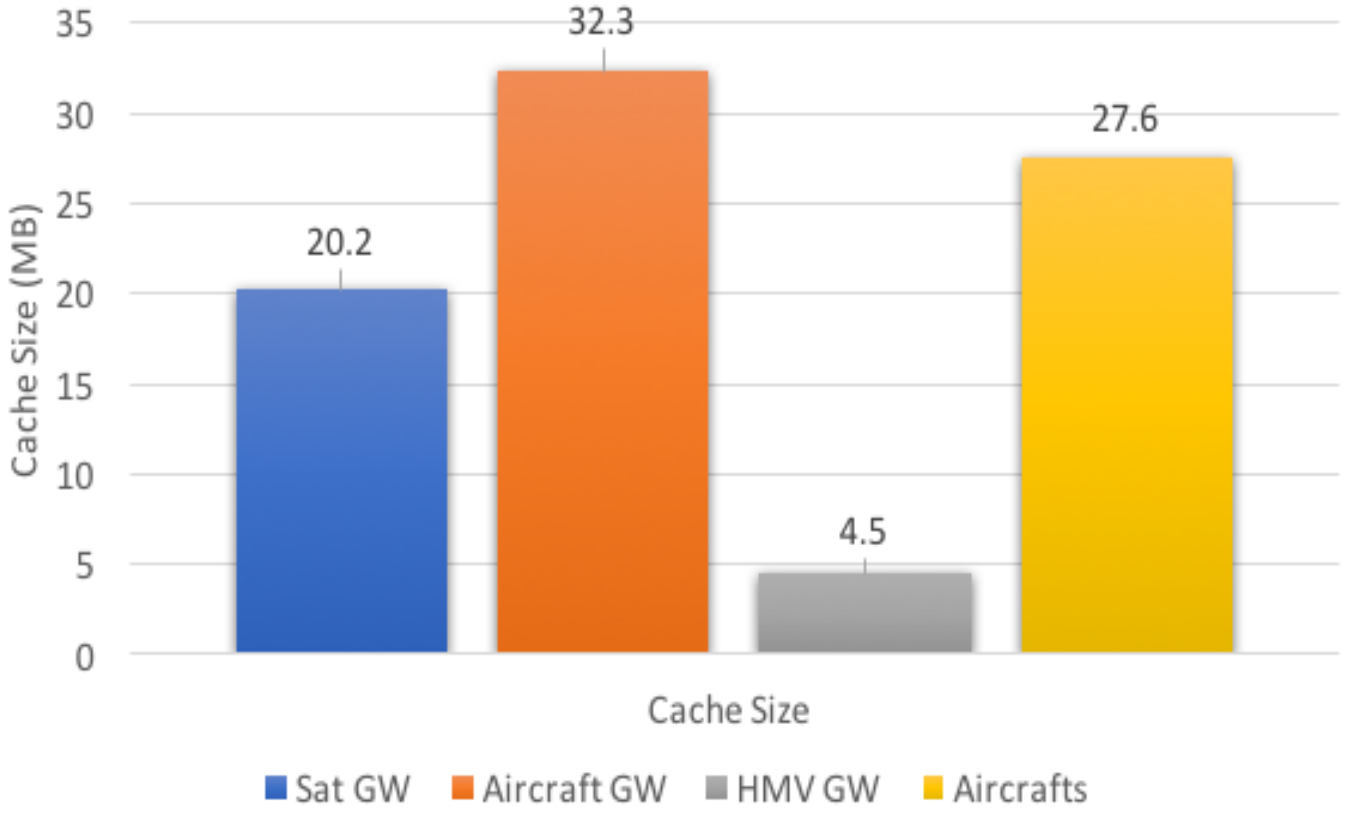
Total data delivered

Total data moved



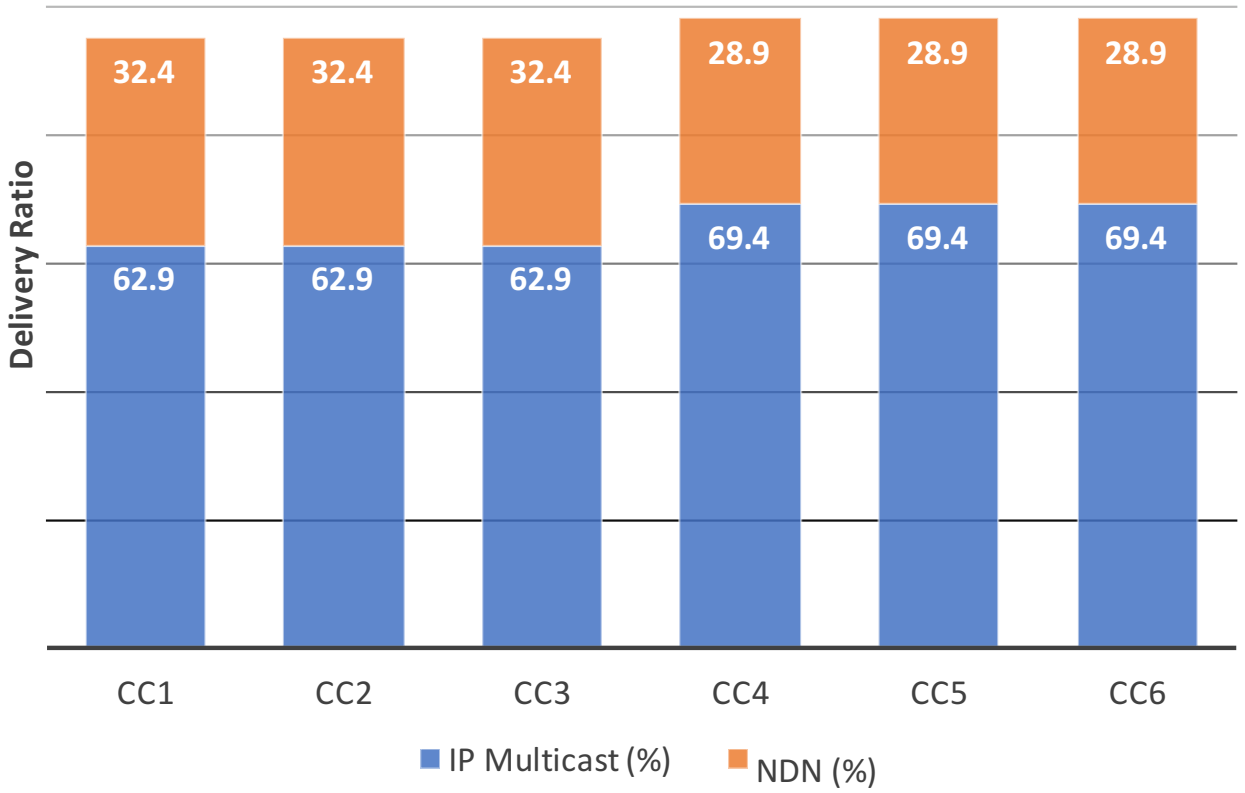
Evaluating NDN: Caching

- Evaluated with smaller cache space
  - Delivery delay increases delivery ratio may decrease (due to cache misses)
  - Outperforms all other mechanism even with caching space = 25% of the total data

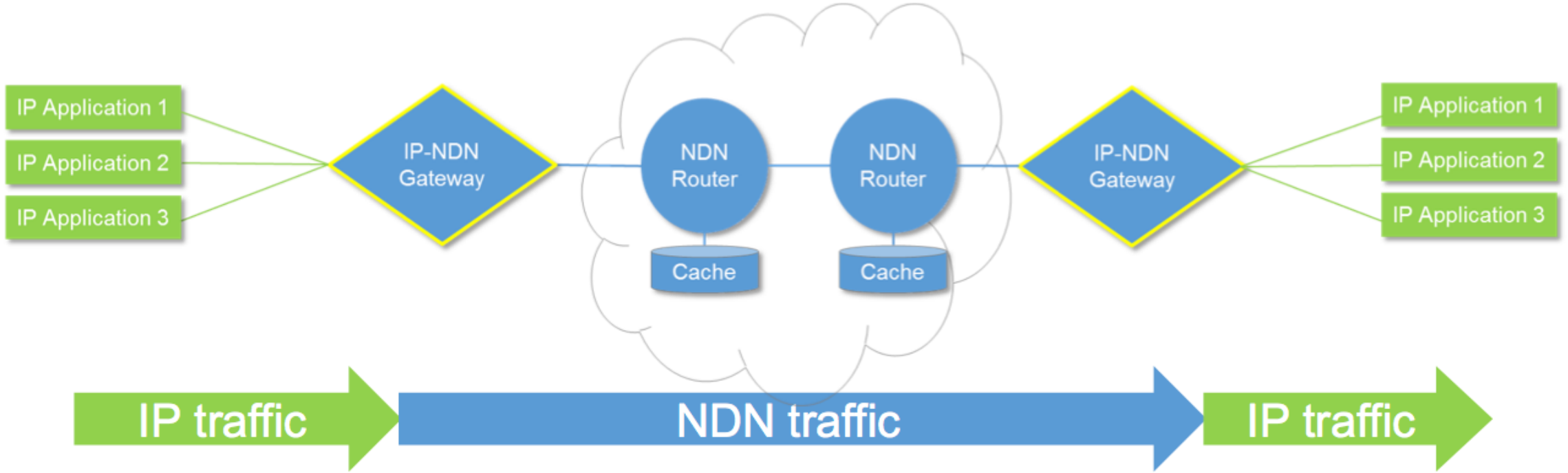


Evaluating NDN: NDN as a secondary transport

- PLI data sent over IP multicast
- Missing location data (i.e. “holes” in the sequence) retrieved via NDN



How to integrate legacy tactical applications?



Cursor-on-Target traffic over NDN

- Seamlessly operate CoT data over NDN
- Significant resiliency gains compared to operation over IP

Conclusion

- NDN improves network resilience even under extreme DIL network conditions
- NDN efficiently utilizes (scarce) network resources
- NDN can be integrated into existing IP infrastructure