Secure, Resilient Pub-Sub Support

NDN Services for Tactical Networks Tutorial

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Military Communications for the 21st Century

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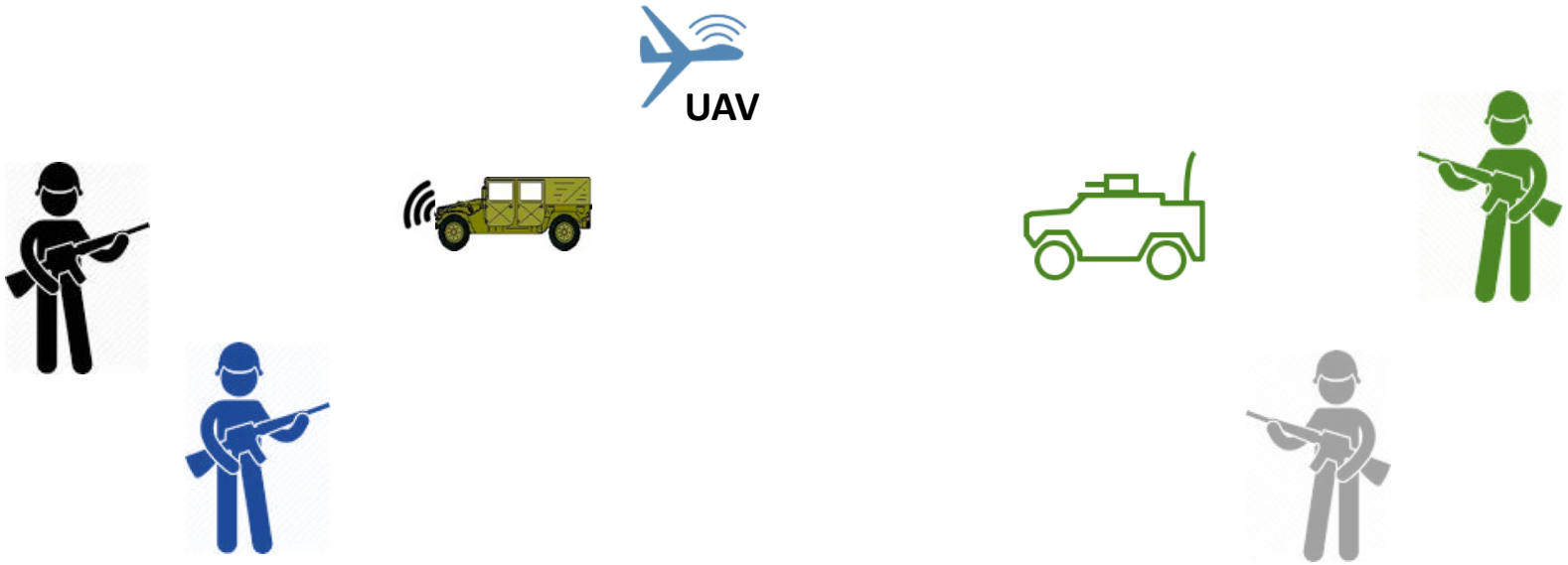
Defining Multi-Domain Command and Control

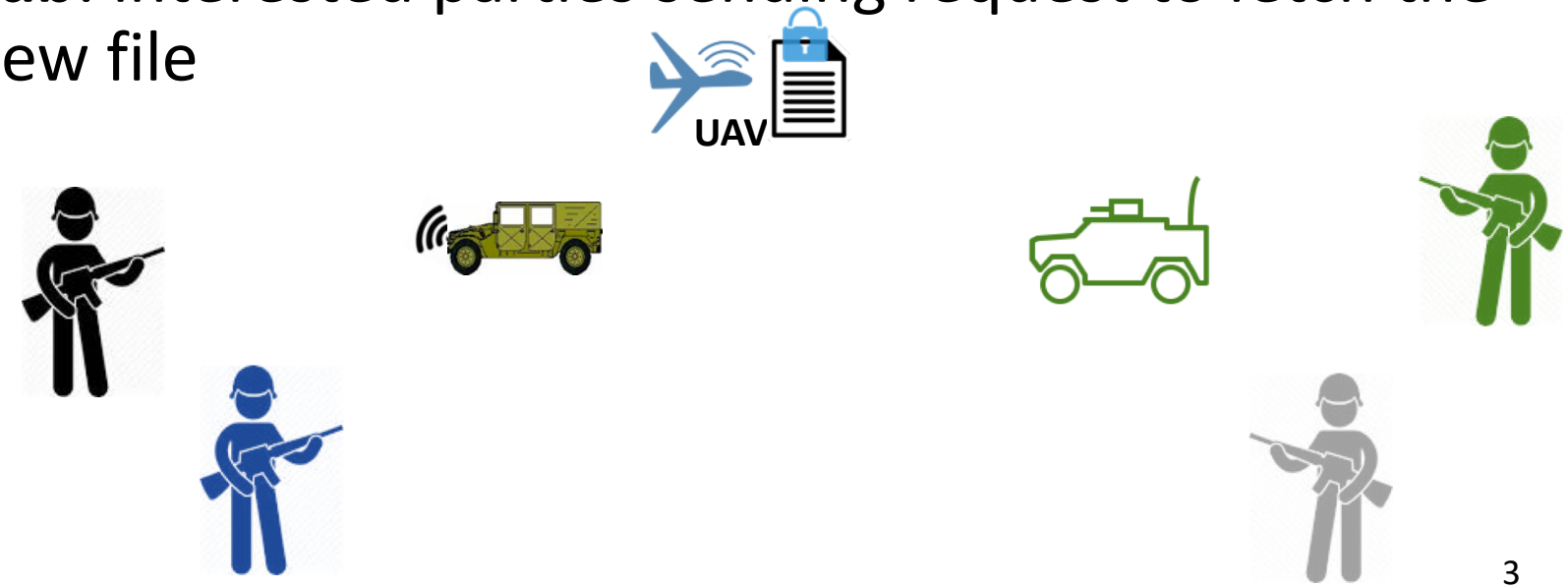
Example application scenario: file delivery

- Any of the multiple entities in the same mission may publish a new file at any time
- Objective: delivering all desired files, newly created or old ones, to all subscribers securely, promptly, and efficiently



Supporting file delivery via Pub-Sub

- **Pub**: a file creator making the file available at the local node as a set of named, secured data packets
  - e.g. UAV produces an image file
- **Sync**: informing others of the newly created file
- **Sub**: interested parties sending request to fetch the new file



Pub: UAV produces an image file

- **Pub**: a file creator making the file available at the local node as a set of named, secured *data packets*
  - e.g. UAV produces an image file, together with metainfo
- Sync: Informing others of the new file
- Sub: interested parties sending request for the new file

- The app registers the file name with the local NFD
- When interest packets with a matching prefix received, NFD will forward to the app

Sync: Keeping everyone informed

- Pub: a file creator making the file available at the local node as a set of named, secured data packets
  - UAV produces an image file
- **Sync**: Informing others of the new file
- Sub: interested parties sending request for the new file

- The app utilizes a NDN Sync protocol to notify others about the new file
- Sync protocol:
  - Encode names of the files
  - broadcast *Sync Interests* to notify others

Sub: efficient, resilient data delivery

- **Pub**: a file creator making the file available at the local node as a set of named, secured data packets
  - e.g. UAV produces an image file
- **Sync**: informing others of the newly created file
- **Sub**: *interested* parties sending request to fetch the new file

- Before request: a small random delay
- Whoever asked first: can suppress duplicate requests
- Vehicle forwards the request
- Returned data packets received by all
- In case of data packet getting lost: retransmitted interest finds closest cached copy

An Overview of NDN Sync Protocols

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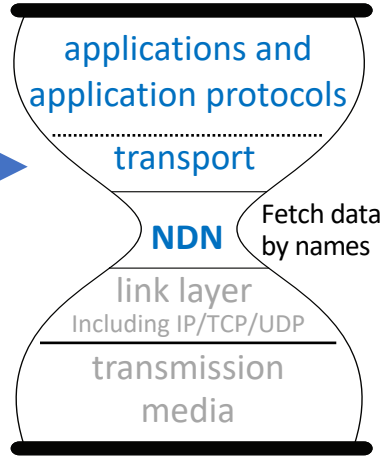
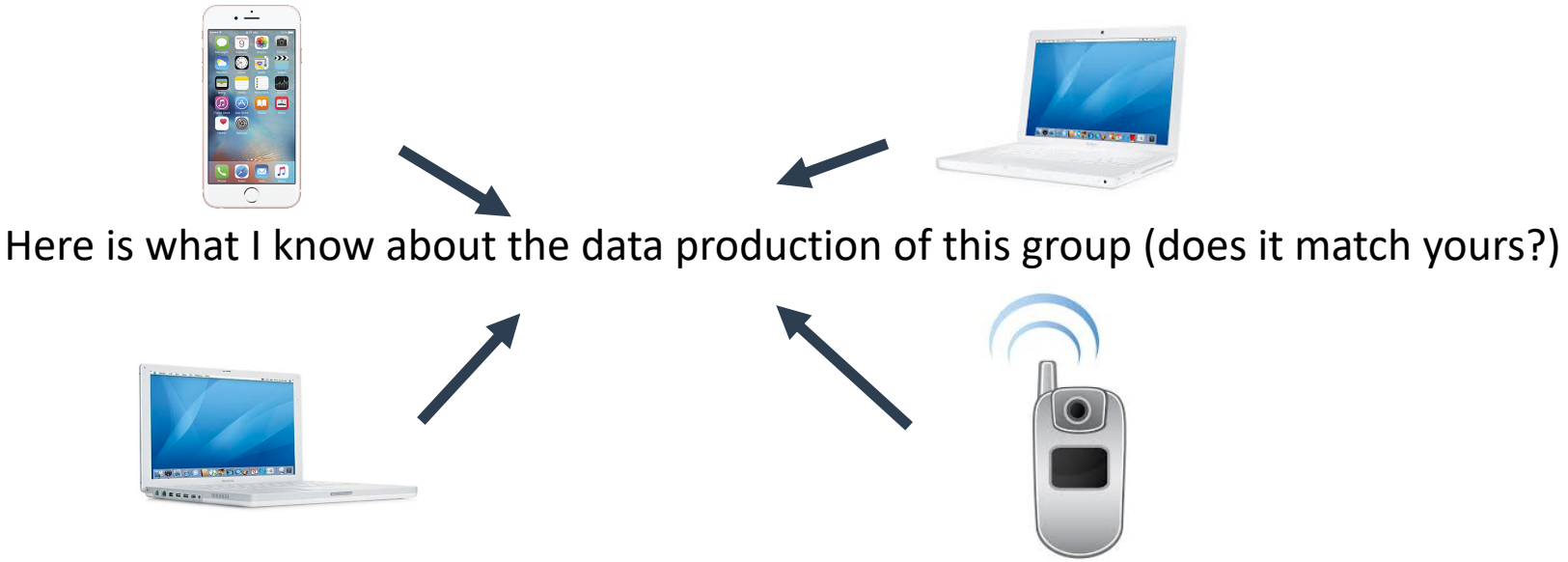
What is NDN Sync

- NDN's data-centric transport *service* [1]
- TCP:
  - Point-to-point synchronous reliable data delivery
- NDN: many-to-many data dissemination
  - Not connected at the same time → asynchrony
  - Heterogeneity of different nodes
    - Conditions
    - Needs/priorities



What is NDN Sync

- NDN's data-centric transport *service* [1]
- Synchronizing the *namespace* of a shared dataset for all the participants in a distributed application

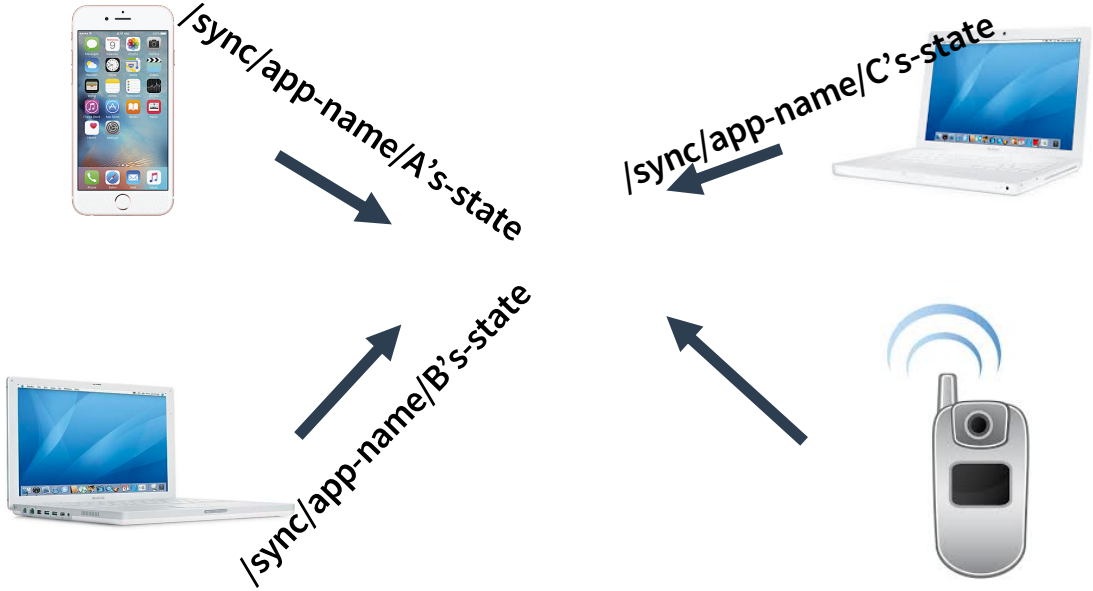


Sync's benefits

- Supports multi-party communication
  - Applications do not need to worry about other participants addresses or how to reach them
- Desired data can be fetched from anywhere
  - Resilient delivery under mobile & intermittent connectivity

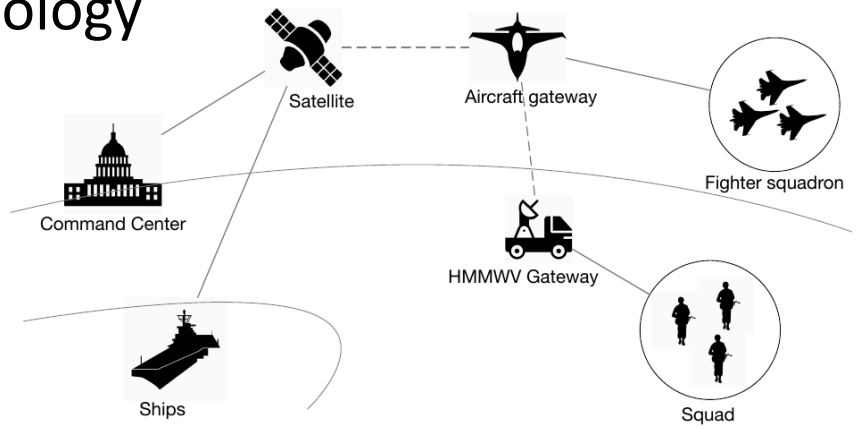
How to Sync

- Encode the data set names into a compact form
- Participants exchange and compare the dataset names to detect differences **(dataset state)**
- Sync protocol reconciles data set names only
  - Individuals decide whether or when to retrieve missing data



Multiple Sync protocols have been studied

- ChronoSync [2]
- iSync [3]
- Partial Sync (PSync) [5]
- State-Vector Sync [4, 7]: particularly suited for sync in scenarios with ad hoc, intermitted connectivity
  - Short-lived connections
  - Dynamically changing topology



Sync in Mobile Ad Hoc Networks

- State vector encoding [A:5, B:7, C:12, …]
  - Carried in each Sync Interest
- Sync interests are event driven, also periodically
- Each party compares state vectors to detect file changes

Supporting file delivery via Pub-Sub

- Pub: a file creator making the file available at the local node as a set of named, secured data packets
  - UAV produces an image file
- Sync: Informing others of the new file
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Takeaway

- NDN Pub-Sub enables secure, resilient, and efficient data dissemination in challenged environments
- Publishers: produce and secure data packets
- Subscribers: fetch desired data
- Sync informs subscribers about the existing data
  - Implemented in NDN libraries

Further reading

1) T. Li, W. Shang, A. Afanasyev, L. Wang, L. Zhang, “A Brief Introduction to NDN Dataset Synchronization,” MILCOM 2018
2) Z. Zhu and A. Afanasyev, “Let’s ChronoSync: Decentralized dataset state synchronization in Named Data Networking,” IEEE ICNP, 2013.
3) W. Fu, H. Ben Abraham, and P. Crowley, “Synchronizing namespaces with invertible bloom filters,” ACM/IEEE ANCS ’15, 2015.
4) W. Shang, A. Afanasyev, L. Zhang, “VectorSync: Distributed Dataset Synchronization over Named Data Networking,” NDN Tech Report 0056, Mar. 2018
5) M. Zhang, V. Lehman, L. Wang, "Scalable Name-based Data Synchronization for Named Data Networking," IEEE INFOCOM 2017 (PSync)
6) X. Xu, H. Zhang, T. Li, L. Zhang, “Achieving Resilient Data Availability in Wireless Sensor Networks,” IEEE ICC, May 2018
7) T. Li, Z. Kong, S. Mastorakis, L. Zhang, “Distributed Dataset Synchronization in Disruptive Networks,” IEEE Conf . On Mobile Ad-Hoc and Smart Systems, Nov 2019

Codebase

- https://github.com/named-data/PSync
- https://github.com/JonnyKong/Sync-MANET: a basic implementation of state-vector sync library, work in progress