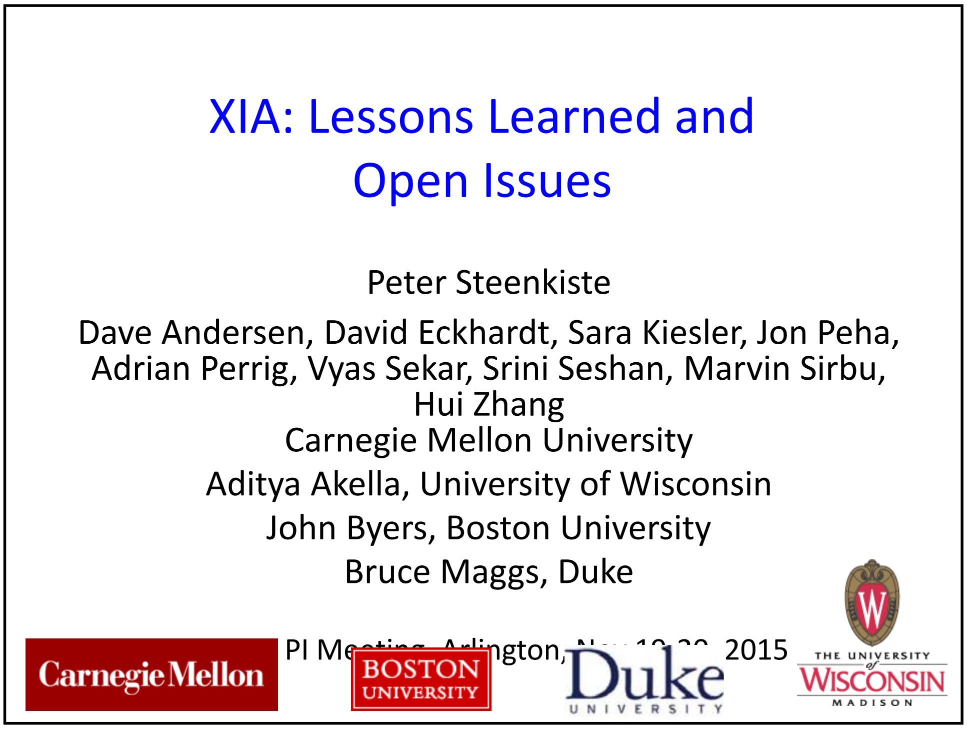

XIA: Lessons Learned and Open Issues

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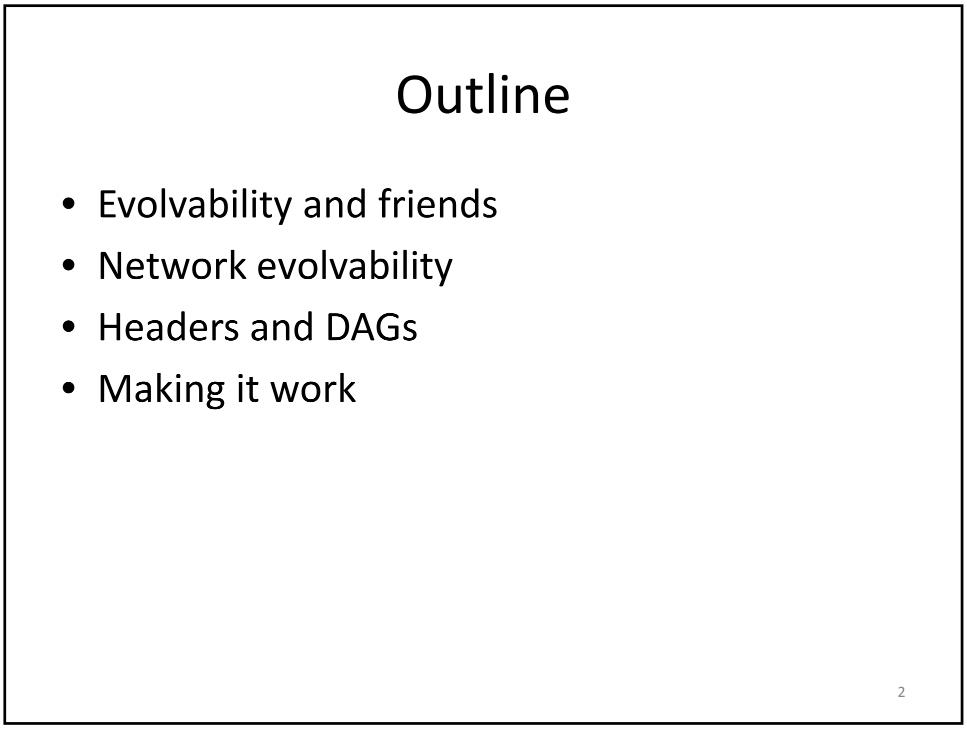
PI Meeting, Arlington, Nov 19-20, 2015



Outline

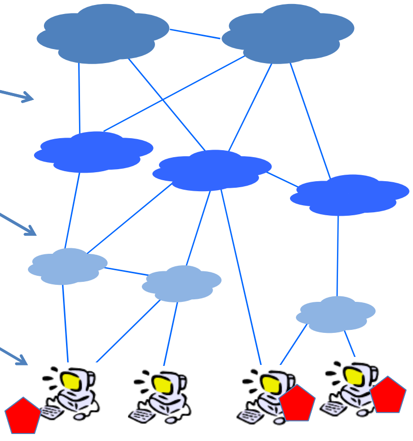
- Evolvability and friends
- Network evolvability
- Headers and DAGs
- Making it work

Evolvability Lessons

- Mechanisms are effective in supporting evolvability
  - Starting with NID and HIDs, added CIDs (content), Scion IDs (path based forwarding), 4IDs (legacy IP), anycast SIDs; working on RIDs, CID variants
- But evolvability mechanisms support other important usage models
  - Customization of networks
  - Discovery function
  - Selective and opportunistic deployment

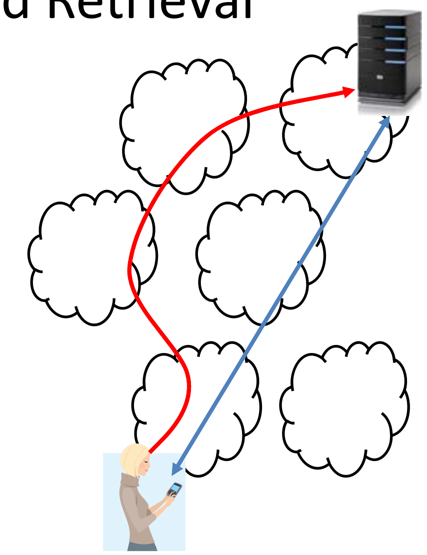
XIA Supports Network Diversity

- XIA in public Internet:
  - Core networks: NID only
  - Eyeball: NIDs plus some value-added services
    - E.g., CID and SID
  - Customer networks can be very diverse
    - Possibly many XIDs
- Edge networks can introduce custom XIDs
  - Unique forwarding or security requirements



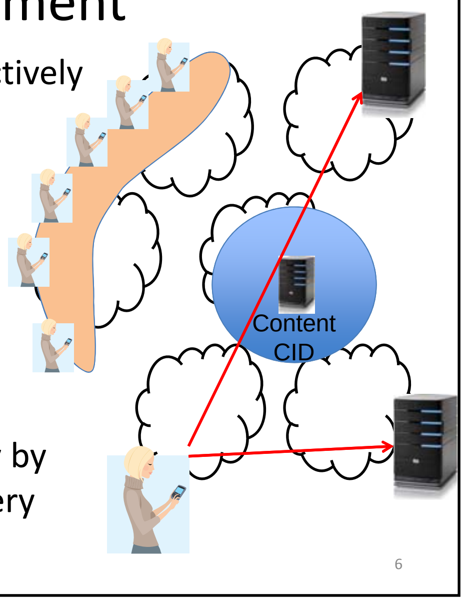
“Fetch” XIDs Support Discovery and Retrieval

- XID first discovers desired destination
  - Anycast, CID, RID
  - Fetch as opposed to send
- Communication session is point to point
  - We use unicast communication (NID/HID)
- Change of end-point addresses is signed
  - Uses intrinsic security



Selective and Opportunistic Deployment

- XIDs can be deployed selectively
  - Business incentives
  - E.g., caching near edge
- Entries can be advertised selective
  - Performance driven
  - Business agreements
  - Custom routing protocols!
- Fallbacks eliminate penalty by allowing in-network recovery
  - Ok to fail



Evolvability Discussion and Issues

- XIDs can represent wide range of “things”
  - Forwarding semantics to “destination”; path-based forwarding; embedding of arch. concepts
- In-network error recovery using fallbacks is very powerful
  - Failures, opportunism, …
- Intrinsic security has been relatively basic
  - Based on pubic keys, hashes; maybe signatures?
  - Original definition probably too strict

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Goal is Network Evolvability - Network layer not sufficient

- Observation: BGP has not changed much
  - Last revision is early 90's
  - Proposed extensions are hard to deploy
- Lots of progress in congestion control
  - But has to be TCP-friendly, defined in ad hoc way
- Socket API has changed … by adding new calls
  - Old calls never go away, e.g., ftp
  - Address type is exposed to application

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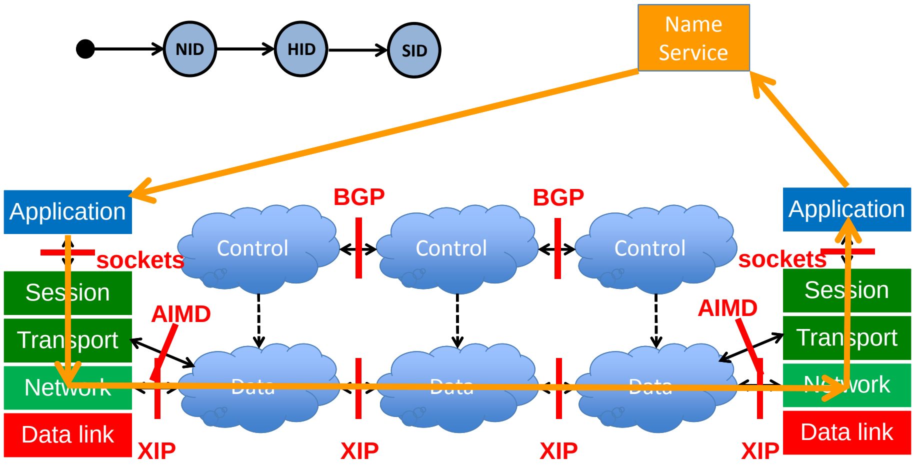
What Interfaces Do We Care About?



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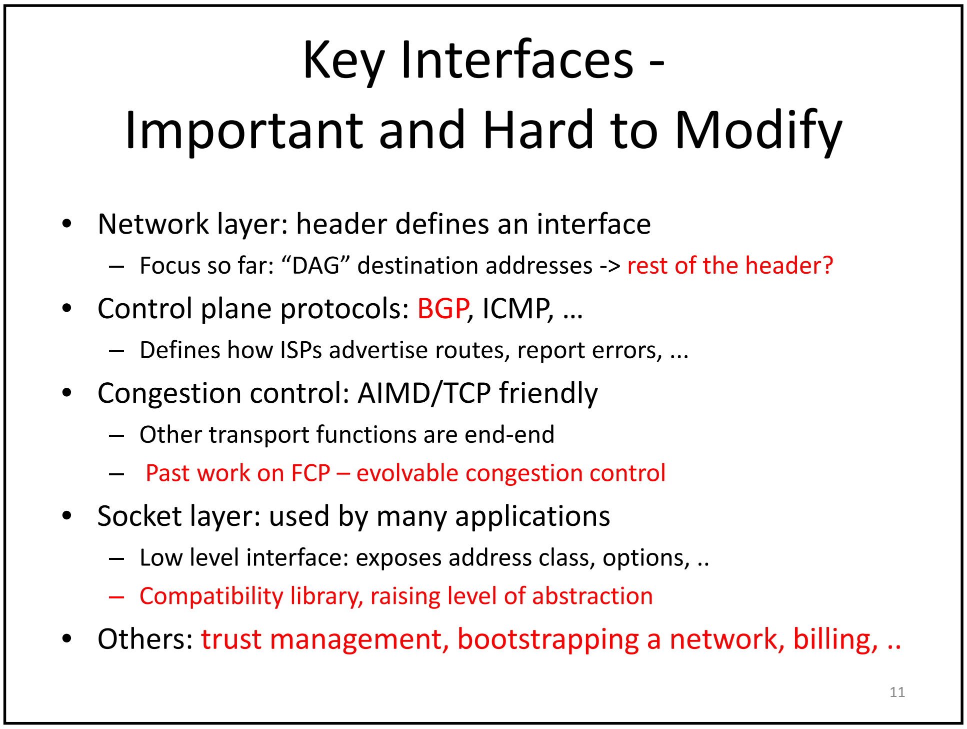
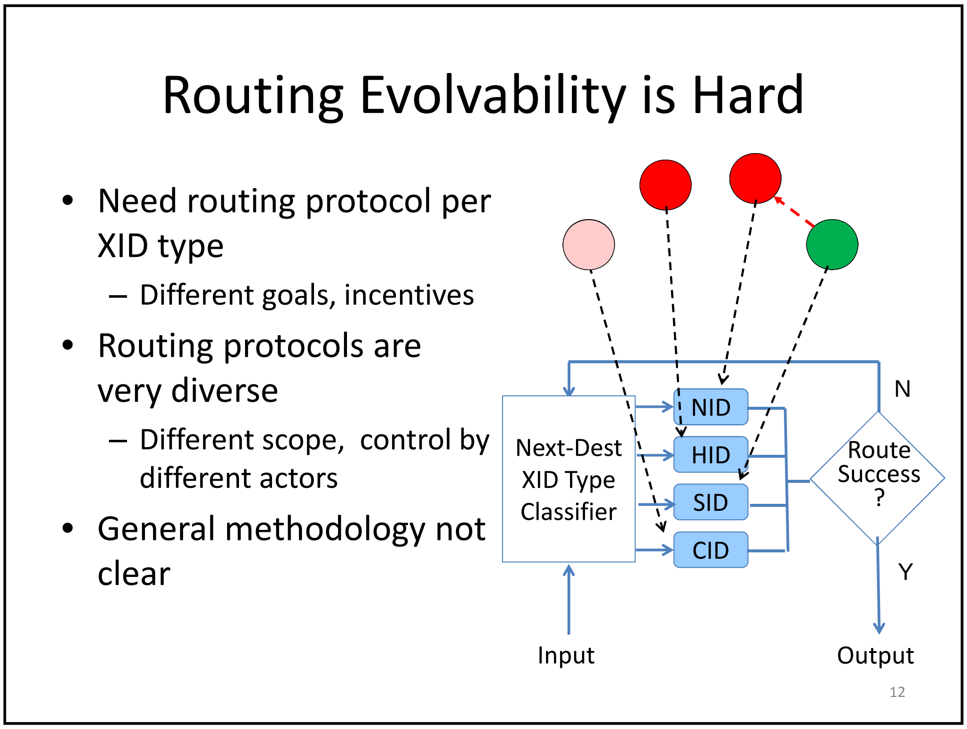


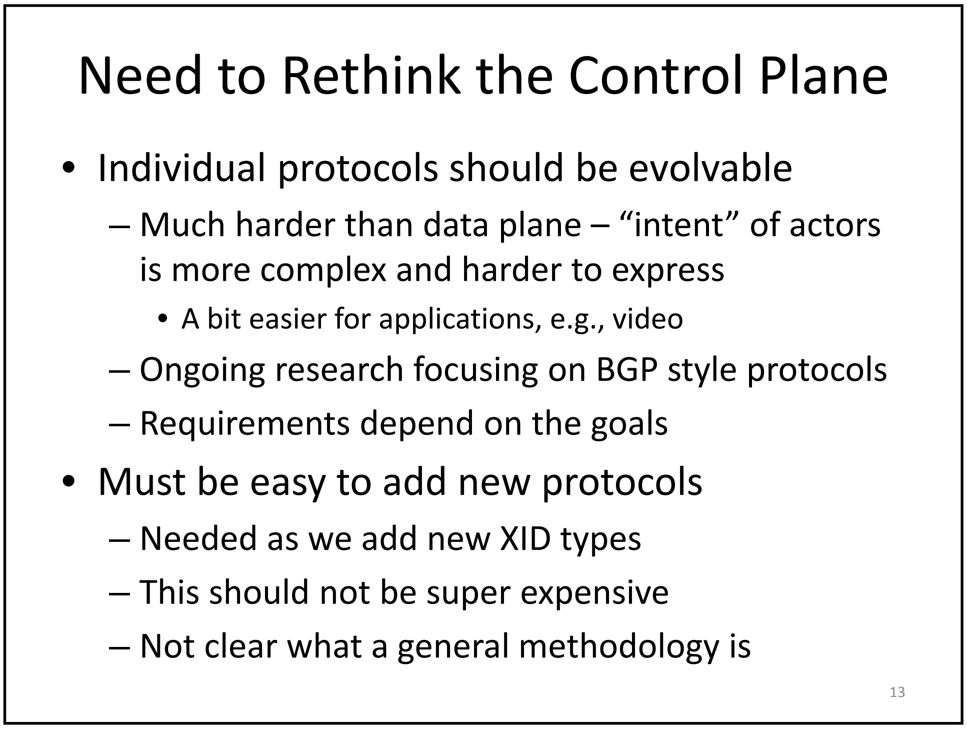
Key Interfaces - Important and Hard to Modify

- Network layer: header defines an interface
  - Focus so far: “DAG” destination addresses -> rest of the header?
- Control plane protocols: BGP, ICMP, …
  - Defines how ISPs advertise routes, report errors, …
- Congestion control: AIMD/TCP friendly
  - Other transport functions are end-end
  - Past work on FCP – evolvable congestion control
- Socket layer: used by many applications
  - Low level interface: exposes address class, options, ..
  - Compatibility library, raising level of abstraction
- Others: trust management, bootstrapping a network, billing, ..



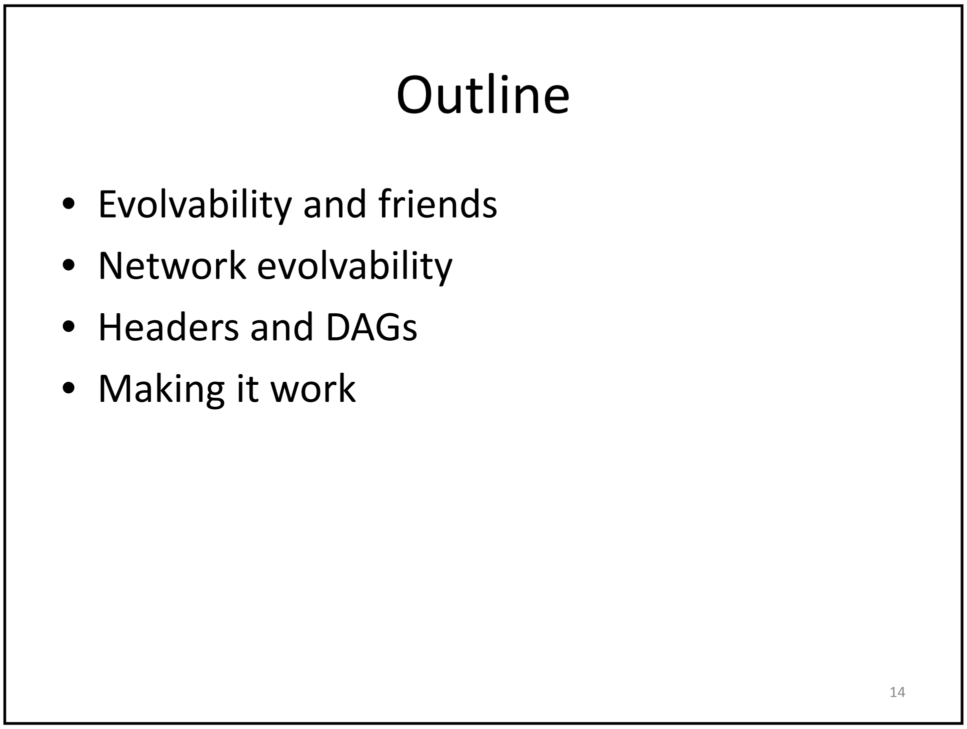
Routing Evolvability is Hard

- Need routing protocol per XID type
  - Different goals, incentives
- Routing protocols are very diverse
  - Different scope, control by different actors
- General methodology not clear



Need to Rethink the Control Plane

- Individual protocols should be evolvable
  - Much harder than data plane – “intent” of actors is more complex and harder to express
    - A bit easier for applications, e.g., video
  - Ongoing research focusing on BGP style protocols
  - Requirements depend on the goals
- Must be easy to add new protocols
  - Needed as we add new XID types
  - This should not be super expensive
  - Not clear what a general methodology is



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Headers – How Hard Can it Be?

- XIA header modeled after IP header
  - Source and destination address (DAGs include both address and SID of the socket)
  - Version, TTL, length
- Source addresses used for accountability
  - Role can be separate from return address
  - A bit tricky fallbacks – need more experience
- Need indication whether content is cacheable – should be separate from source address

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DAGs – Manageable but a Bit Messy

- Constructing good DAGs is a bit tricky
  - Should not be left to users or applications
- General idea: destinations (services) advertise their DAG but senders can modify it
  - E.g., insert in-path services, policy issues, ..
  - Should be done by a package
- Client node get DAG from network
  - Customization done using place holder XIDs
- Policy compliance checking easy for simple DAGs
  - Limited experience with complex DAGs

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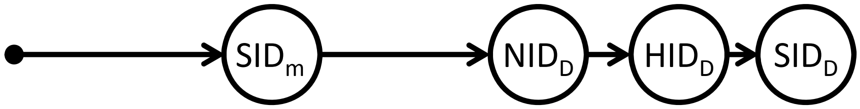
What Does This mean?



- SID_m is visible (non-transparent) middlebox
  - Trusted by source since it inserted the SID in DAG
- Can be used for any traditional middlebox
- Also used for custom forwarding or address translation services
  - Rendez-vous mobility service, inserting Scion ID
  - More general: delegating address creation

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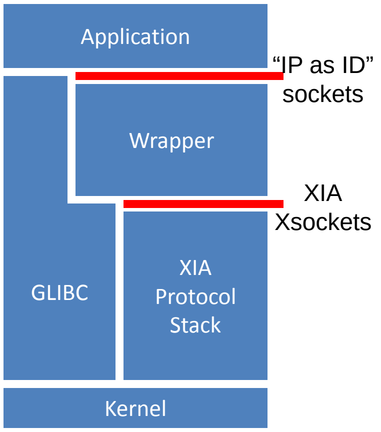
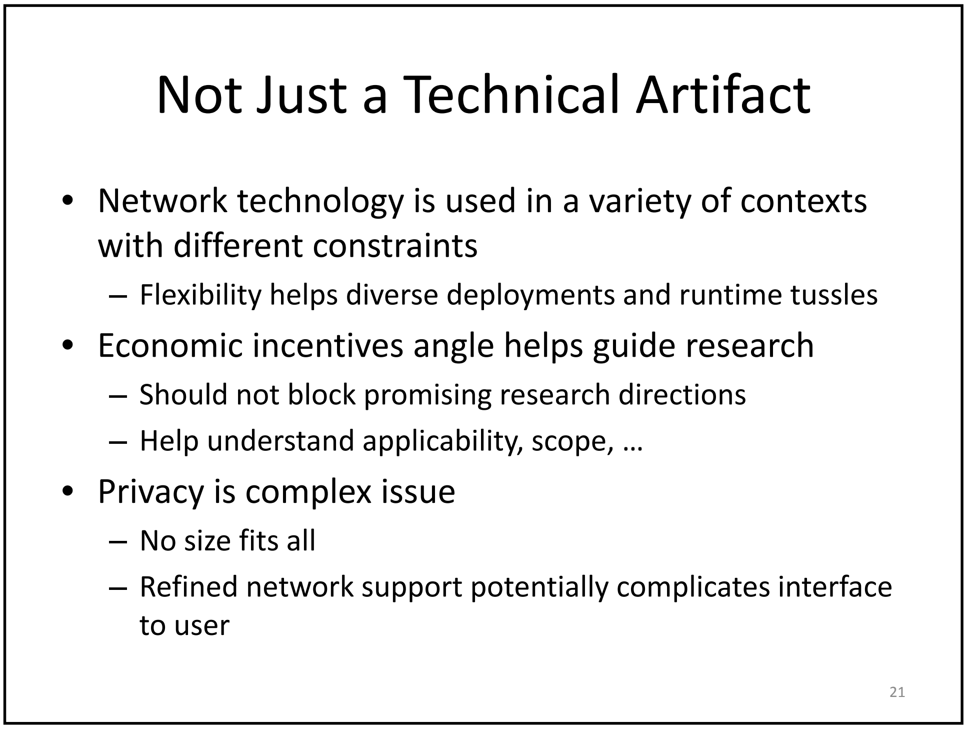
Porting Applications is a Pain



- And it is mostly not research!
- XIA xsocket = ~IP sockets + get and put chunk
- Solution: translates IP socket calls automatically and add CID calls manually
  – The latter is research!
- Solution is based on a wrapper library
  – (IP, socket) -> XIA DAG
  – Kind of like a weird NAT
- Discussion? Experiences

Protocol Stack Rethinking

- Some XIDs push application layer concepts to the network layer
  – Content, services, "discovery", …
  – Jumps over the transport layer
- These concepts are application independent
  – But in practice applications need application specific meta data, e.g., HTTP vs GetChunk CID
- General question: difference between an XID and a protocol – how much header needed?



Not Just a Technical Artifact

- Network technology is used in a variety of contexts with different constraints
  – Flexibility helps diverse deployments and runtime tussles
- Economic incentives angle helps guide research
  – Should not block promising research directions
  – Help understand applicability, scope, …
- Privacy is complex issue
  – No size fits all
  – Refined network support potentially complicates interface to user

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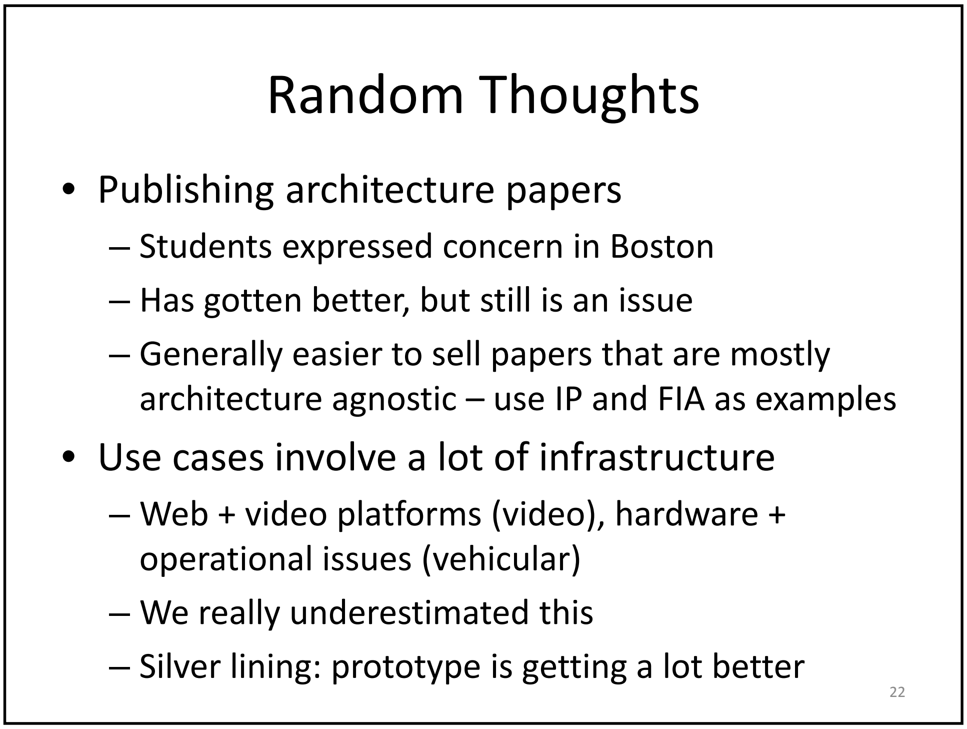

Random Thoughts

- Publishing architecture papers
  – Students expressed concern in Boston
  – Has gotten better, but still is an issue
  – Generally easier to sell papers that are mostly architecture agnostic – use IP and FIA as examples
- Use cases involve a lot of infrastructure
  – Web + video platforms (video), hardware + operational issues (vehicular)
  – We really underestimated this
  – Silver lining: prototype is getting a lot better

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Questions?
Discussion?

More Topics (short)

- Different XID types need different ctl protocols – reflects semantics – not just BGP++
  - Several of these protocols look, well, quite different – any general concepts?
- Services allow visible in-path services, specialized forwarding semantics (based on header, …)
  - Changes architecture